

Microeconomic Applications In International Trade Theory

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Abstract

This Thesis titled Microeconomic Applications in International Trade Theory aims at examining the role of government intervention in a number of likely scenarios on an International Trade level.

The Introduction provides a general overview of this work. Chapter 1 provides a solution to the inefficiency problem arising when a cost asymmetry is introduced in a strategic trade framework, when oligopolies compete in the third market. A lobbying contest is used to identify the cost efficient firm, which then receives a subsidy à la Brander and Spencer and exports in country three. Welfare enhancement opportunities arise from this intervention. Chapter 2 analyses all the potential for cooperational agreements to arise between firms and policy makers in the Strategic Trade context, when monopolies operate in the two producing countries. The measures used by the governments and the consumption levels in the three countries involved will define the likely outcome of such schemes. Chapter 3, looks into the role of government in providing incentives to a foreign firm that aims to enter its market, in such a way that it will alter its optimal entry mode, should this differ from the welfare enhancing, and thus preferred, mode of the government. The findings show that there is potential for mode switch incentivising measures to be accepted, particularly in a small market framework. Chapter 4 provides an overall conclusion to the analysis.

Declaration

I certify that this thesis is my own work and has not incorporated without acknowledgement any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person where due reference is not made in the text.

Evangelia Alevyzaki

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Introduction

International trade protectionist tools, in the form of subsidies and taxes, and their potential effects on the welfare and profit levels of countries and firms respectively have been widely analyzed by trade theorists.

According to the theory, countries can take two different approaches towards international trade: oppose or embrace it. In the former case, the protectionist tools can be used in an effort to deter the entry of foreign firms in the market, in order to protect their national firms, whereas in the latter case, policy instruments can be used as incentivisation measures to attract more trade. Particularly for the latter case, lower taxation can be used as a measure to attract foreign direct investment that has been gradually replaced exporting as an international trade method.

The following analysis will draw from both theory streams and focus firstly on the theory of strategic trade, where subsidization is used as a tool of promoting the position of the one country's own firms in an importing country, relative to their rival's (Brander and Spencer [8]). Thus, the policy measures provided are used as protectionist tools. As will be described in the thesis overview, Chapter 1 focuses on the cost efficient firm identification in a situation where an oligopoly competes against a monopoly for rent shifting from the importing third country. The second chapter focuses on the potential arising of cooperational agreements between the two rival countries and the role the protectionist may play in them.

Turning to the situation where governments may not oppose trade, but actually welcome it, in the form of efforts to attract foreign direct investment or increasing trade by relaxing potential barriers, Chapter 3 focuses on the role of government policy in a bid to influence a foreign multinational's entry mode choice.

Thesis Overview

In summary, the aim of the analysis undertaken in the three chapters comprising this work is to examine the role of the government in the decision making of firms in a number of situations on an international trade level.

The first chapter aims to provide an answer to the inefficiency problem arising from the introduction of a cost asymmetry in an oligopolistic model of Strategic Trade Policy. In this we find that the use of a lobbying contest in the heterogeneous market can succeed in revealing the highest efficiency firm, as through the use of a contest, firms will expend efforts according to their abilities. Consequently, the lowest cost firm will expend the highest effort, and so the winner of the contest will be the firm that the government seeks to reward. The exertions of the participants in the contest therefore serve as signals of the particular ability of the players, hence the highest ability one will be the winner. This will be the most advantageous option for the government to set as the national champion that will compete in the international level against a single foreign firm. This in turn leads to the reduction of the a la Dixit oligopolistic asymmetric cost strategic trade model to a monopolistic one, which will either entail a cost asymmetry between the rival country monopoly firms or a cost symmetry. This will depend on the cost of the national champion compared to the cost of the foreign rival. We also show that the lobbying contest can be

welfare enhancing compared to the asymmetric oligopoly model under certain market and cost conditions.

The second chapter examines all the possible co-operational outcomes, when the assumption of no cooperation introduced in the seminal paper by Brander and Spencer in their strategic trade model is relaxed, when the two rival monopolies are characterised by cost asymmetry. Firstly, a brief overview of the three potential types of agreement is provided, followed by a detailed examination of the outcomes using a linear approach. The particular outcome of the scheme, under constant marginal costs is shown to depend on the level of cost asymmetry and the consumption levels in the producing countries. The cost asymmetry level and the market size play a significant role in a decreasing marginal cost setting. The willingness of policymakers to support cooperation is crucial for the final outcome.

The third chapter is based on the observation that in recent years, a number of countries have been providing incentives to attract FDI, mostly in the form of lower taxation levels or some form of subsidisation. It aims to analyse the situation where a government would use subsidisation or taxation policies as incentives for firms to change their mode of entry towards the most welfare enhancing for the host country, when the firm optimal and the government optimal entry modes differ. To do so, we compare the three alternative entry modes that a firm may adopt in its effort to enter a foreign market, namely exports, greenfield FDI or acquisitions (brownfield FDI). The examination takes place in both a full and asymmetric information environment and the ability of the policymaker to affect the

entry mode depends on the level of the greenfield investment cost relative to the particular policy measure adopted.

Chapter 1

A Contest Application in Strategic Trade Theory

1.1 Introduction

The theory of strategic trade policy has been a major issue of debate amongst trade economists throughout the years. The original Brander and Spencer [8] model, where the monopoly firms of two producing countries compete in a third country, which only imports the good, was based on a set of simplifying assumptions, which when relaxed lead to alterations to the results of the analysis. In particular, Dixit [25], in an oligopolistic version of the Brander and Spencer model of strategic trade policy, shows that the number of firms in each of the two competing countries will define the optimal uniform policy measure, under the assumption of firm cost symmetry. The allocation of the optimal measure may be inefficient, when cost asymmetry is introduced. Hence, when the firms operating in the exporting markets diverge in their production cost levels it should no longer be optimal to allocate uniform measures and subsidise/tax all firms in a similar manner depending on their number.

In the a la Dixit framework, particularly for the case where the number of firms in the country with the active government is greater than the number of producing firms in the rival country, the optimal measure would be a tax. The inefficiency that this taxation would try to overcome would still exist in the form of the inability (due to the tax) of the lowest

cost firm to alone compete in the international market and succeed in the profit shifting aim of strategic trade policy.

Particularly for the case where the social cost of funds exceeds one, and the policy measure is not a pure transfer, Leahy and Montagna [52] have suggested a solution to this uniform measure allocation inefficiency. This takes the form of the provision of firm specific measures, with the lowest cost firm awarded a positive subsidy that will facilitate competition in the third market framework and firm specific taxes to the remaining less efficient firms, to deter them from producing for exports in the importing third market. The shortcoming of this approach is the lack of an identification mechanism as the cost for each firm is assumed to be privately observed by the firm. Focusing firstly, on the situation where the policy measures are a pure transfer (in contrast to the Leahy and Montagna model), and taking the above shortcoming into consideration, the following analysis provides a solution to this inefficiency problem arising from the provision of uniform policy measures in an oligopolistic model. As Leahy and Montagna suggest, the allocation of firm specific measures would be more efficient, enabling only the lowest cost firm to compete and shift rents from the third market. I find that the use of a lobbying contest in the heterogeneous market can succeed in revealing the highest efficiency firm. This in turn leads to the modification of the *a la* Dixit [25] oligopolistic model, under cost asymmetry, to a monopolistic one; the actual level of the national champion's cost will define whether this monopolistic model will be similar to the one introduced by Brander and Spencer [8], which is characterised by cost symmetry between the two rival monopolies or the one analysed by Neary [61], which is characterised by cost asymmetry.

Hence, a lobbying contest is used as an identification mechanism. Using a contest model, where the optimal bidding of the firms depends on their particular production ability (the lower the marginal cost of production, the higher the efficiency) we derive the following results: the most efficient of the firms will be the one submitting the highest bid, and therefore will be the winner of the contest. This then will receive the award provided by the government (subsidy) whilst the rest of the firms will only incur the cost of entering the contest and will not be able to produce for the international level. This could be thought to serve the same purpose as the firm specific tax suggested by Leahy and Montagna, albeit in our model the cost is sunk and is not included in the welfare function. Therefore we are able to provide a solution for the specific shortcoming, both in the case where the policy measure is a pure transfer and when it is not. We also show that the lobbying contest can be welfare enhancing compared to the a la Dixit asymmetric oligopoly model, under certain market and cost conditions, both in the case where there is a social cost associated with the provision of the policy measures and when there is not.

The rest of the paper proceeds as follows. Section 1.2 provides a review of the literature on strategic trade theory and the use of lobbying as an identification mechanism. In Section 1.3, the lobbying contest model is introduced, followed by a welfare analysis, firstly for the situation of a pure transfer policy measure and then for the case where a social cost of funds is associated with the measure-provision. Section 1.4 concludes. Supporting proofs are contained in Appendix A.

1.2 Literature Review

The two main models of international trade theory directly related to the following analysis are firstly Brander and Spencer's Export Subsidies and International Market Share Rivalry [8], in which two national monopolies compete in a third market framework to shift rents with the assistance of policy measures provided by active governments. The second is Dixit's International Trade Policy for Oligopolistic industries [25], in which more than one producing firms operate in the two competing countries and provide output to be exported in the third market.

In more detail, the seminal paper by Brander and Spencer [8] states, that unlike previous models of international trade theory where in the case of perfectly competitive markets, protectionism was not an optimal strategy, when the market was for any reason imperfect, then the most advantageous tactic for governments would be to safeguard their markets. Two producing countries compete for their share in the sales and profits derived from a third non-producing country. Production in each of the two countries is undertaken by a monopoly, that receives a subsidy by their respective government. This aims to assist in the shift of rents towards the country receiving the highest policy measure. Essentially, as Brander described in his literature review [7], a government can not help its own firm in any other way, apart from the provision of a protectionist measure that provides a credible threat and assists in placing the firm in a Stackelberg leader position. This is the reason why, when both governments are active in this model, a subsidy war arises, in which each government expends an effort to assist its own firm. The basic model, with only one active firm, takes the form of a two stage game, in which the first stage involves the decision

of the government to set the optimal export subsidy for its firm and the second stage sees the setting of the optimal production level to export in the third market simultaneously by both firms. Backward induction is used to derive the optimal subsidy level, set by the government that seeks to maximize its objective function, the welfare function consisting of the profits the monopolistic firm captures in the third market, minus the subsidy bill. A number of extensions of the particular model were introduced in the literature, based on alterations of the assumptions used by Brander and Spencer, such as the introduction of cost asymmetry between the two rival monopolies, as described by Neary [61]. A more detailed exposition of the Brander and Spencer [8] model and the Neary [61] extension is provided in section 1.3.1, as it is important for the analysis of this paper.

The more general case of oligopolistic rival markets was addressed by Dixit [25]. He used a reciprocal market model with more than one symmetric firm operating in the two competing markets. The reciprocal market model implies that in contrast to the original monopoly model, the two countries are able to export to each other's market. The result that he arrived at was that in contrast to the outcome of the Brander and Spencer article, if the number of domestic firms is higher relative to the foreign ones, then a subsidization policy might worsen instead of improve domestic welfare. Then, the suggestion was for the government to follow an export taxation policy, rather than subsidization of the producing firms. In order to exhibit more clearly the difference between the policies suggested by these two models of strategic trade policy, a third market model could be used, without loss of generality (Montagna, SGPE 2003/2004 lecture notes). The results remain unchanged: if the number of domestic firms n exceeds a critical value, the optimal policy is taxation.

This, because of the fact that a subsidy has two contrasting effects on domestic welfare: one stemming from the rent shifting (comparative advantage result) and one from the domestic competition (excessive domestic production). The first promotes domestic welfare, whilst the latter reduces it. The higher the number of domestic firms relative to the foreign ones, therefore, the more likely it is that the negative effect will dominate, and so a subsidy will cause the decrease in domestic welfare.

The analysis of the above models is based, however on the assumption that the countries are symmetric and that firms within each country are identical. In the real world that would be rather unlikely to occur. If cost asymmetry was introduced in the oligopolistic framework, incorporated in the difference between the number of domestic and foreign firms (i.e. domestic firms more than foreign ones and so the optimal policy is a tax, or with the opposite results), then we would depart slightly from Dixit's conclusion. In this case, as N.Van Long and A. Subeyran [76] show, the concentration of the firms, measured by the Herfindahl index¹, along with the concavity or convexity of the demand curve will define the optimal protection policy. Hence, they come to the conclusion that in the cases where (i) the demand curve is convex ($P'' > 0$) and the index is high and (ii) the demand curve is concave ($P'' < 0$) and the index low, the subsidisation policy is beneficial as it increases domestic welfare. However, in the two opposite cases, where (iii) the demand

¹ The Herfindahl index of industry concentration measures industry concentration by imposing added weight to the bigger firms. The formula is: $H = (\%S_1)^2 + (\%S_2)^2 + \dots + (\%S_n)^2$, where S counts the share of the market owned by each of the company in the market. In the case where the costs are not identical, then some firms will have a higher share, and some lower, compared to the case of identical firms. The greater the difference of the shares captured by the different firms, the higher the index and therefore the higher the concentration of the market power in the 'hands' of a small number of firms. Thus, the lower the competition within the market. The index takes its highest value of 10,000, in the case of a monopoly, where all the market power is concentrated on one firm. The larger the number of firms and the lower the dispersion of the costs, the lower the index.

curve is concave and the index is high and (iv) the curve is convex with a low index, then if the government were to impose a subsidy, it would lead to a reduction of welfare. Thus, in these two cases, the optimal policy would be to tax exports. The government will impose a uniform tax for all firms, leading to an inefficient outcome as the output of the most efficient firm will be restricted. This firm in any other situation would be the one managing to shift the highest amount of rents from the second competing country (if it were to compete on its own). The government would be able to increase domestic welfare if it could find a way to award only the most efficient firm.

A proposed solution to avoid the inefficiency of uniform policy measures comes in the analysis of Leahy and Montagna [52], [53], [54], which suggest the following strategies. In the last of these papers [54] they consider the case of the implementation of a firm-specific subsidisation policy, when only the domestic government is policy active. They show that when the social cost of funding this policy is not too high, then the firms should receive subsidies according to their production abilities (i.e. production costs). Consequently, the higher the deviation of the marginal cost from the market average, the higher the subsidy they will receive, and so the higher their level of production in the international level. If on the other hand the social cost is high, then the optimal policy is a set of firm specific taxation measures, with the lowest cost firm, which has the highest production capability, required to pay the highest per unit tax. This will ensure production of only up to the level the government allows. The policymaker, when the social cost is high is interested in minimizing the subsidisation costs and no longer in the maximisation of the profit shifting. Therefore, the argument of rent-shifting that originally drives the activity of the government

is weakened. The minimisation of costs is granted through the taxation of the firms with the larger share of the market, i.e. the cost- advantaged ones.

The social cost of funding plays a major role in the models, as this cost will define whether a policy maker would be at all willing to provide a positive subsidisation measure. When the parameter capturing this cost is unity, and equal weight is put on the government expenditure and the profits of the firms, then the most likely policy is subsidisation, as seen in models such as Brander and Spencer [8]. However, in reality, it is rather unlikely that this should occur, for reasons that as Leahy and Montagna [53] state, vary from the fact that 'a cost is incurred by society in the process of transferring purchasing power from the taxpayers to the government' or that firms may not be fully owned by domestic owners and thus 'not all profits will accrue to domestic owners'. Therefore, different policy measures are to be adopted, especially in the case of a domestic oligopoly. When the parameter is greater than one and thus the subsidy payment is no longer a pure transfer but is more costly for the government, then providing a positive uniform subsidy to all firms in the market proves welfare reducing as it distorts the economy. The analysis in Leahy and Montagna [53] suggests that: 'the government should select winning firms within industries', or in other words they should try to select and support an industry champion.

This in Leahy & Montagna [52] is done through the provision of a firm specific subsidy to the most efficient firm and firm specific taxes to all the remaining ones, instead of a unit subsidy towards the entire domestic market in order to succeed in the prevention of the effect of the excessive production. The tax will prohibit their inefficient export production and since only the most efficient of the firms will be competing in the third market,

then the game reduces to the Brander and Spence framework, where the subsidy will only have a rent shifting effect. However, it is also mentioned in this article [52], that ‘one of the criticisms levelled against strategic trade policy concerns the ability of the government to identify the strategic sectors. The need to be able to identify the winning firms within an industry may be seen as casting further doubts on the feasibility of implementing strategic trade policies’. So the setback in this model is the lack of government ability to identify the production cost and pick-the-winner.

The criticism therefore would lie on the inability of the government to identify the cost efficient firm in the market. Hence, incomplete information on the policymaker’s part characterises the market. The argument here would be that a mechanism is required to assist the identification of the most efficient firm i.e. the firm that produces with the lowest cost.

The identification shortcoming mentioned in the Leahy and Montagna [52] analysis also applies in the situation where no social cost of funding is involved in the provision of the policy measures, but rather they are considered to be a pure transfer. Even in this case, inefficiency would still arise, linked to the fact that the lowest cost firm is unable to solely compete in the third market. This is addressed by the lobbying contest, which aims at providing a solution to the above described identification problem, revealing the low cost firm in the market. It also provides a likely solution to the uniform policy measure problem, by providing a firm specific subsidy to the lowest cost firm, in the form of the contest award. This chapter of my thesis addresses the issue, under both the assumption

that the measures are a pure transfer and when there is a social cost associated with their setting.

The relationship of the Brander and Spencer [8] and the Dixit [25] models and the one to be created in the following analysis, mainly stems from the fact that Dixit's model of oligopolistic industries when the producing firms differ in their production costs can be reduced to the Brander and Spencer monopolistic model, through the use of a lobbying contest. A lobbying contest would allow the winner to become the monopoly in the country, as in Brander and Spencer, leaving the remaining firms incurring only the contest entry cost and not producing for the third market (these would be the remaining $n - 1$ firms from the Dixit Oligopolistic model). This as already stated provides a solution to the inefficiency created when the lowest cost firm in the oligopoly is not allowed to compete as a monopoly in the third market, but instead is awarded with a uniform policy measure, that may impede with the chances of this firm to shift the maximum amount of rent.

In the context of the model to be analyzed both these assumptions are useful. The existence of a number of firms in country one, where these differ in the production cost can interact with the existence of one firm in country two that will either have a cost equal to or different from that of the national champion emerging from the lobbying contest.

Therefore, the reduction of the Dixit oligopolistic model to the Brander and Spencer one, where the national champion emerging from the lobbying contest will compete with the monopolistic firm of country 2, may lead to the competition between two cost asymmetric firms in the third market. For the case of asymmetry between the cost levels in the two rival countries, the literature provides us with the following findings: Neary [61] de-

parts from the original Brander and Spencer model, introducing firstly a cost asymmetry between the private and social costs for the policy measure provision and a cost asymmetry among the two rival monopolies (i.e. the cost of production differs between the domestic and foreign firms), competing in the third market setting. When an asymmetry exists between the private and social cost, Neary [61] obtains the optimal policy measure to be provided by the intervening policy maker and shows the depending on the value of the social cost of funds parameter, the optimal measure can be a tax or a subsidy. He then shows that when the parameter capturing the social cost of funds does not exceed a certain threshold value and the measure proves to be a subsidy, this optimal subsidy to be provided is a decreasing function of the domestic marginal cost and an increasing function of the foreign cost. Therefore, the more cost efficient the domestic firm is, the higher the incentive for the domestic government to provide a subsidy, and in this manner improve the chances of profitable rent shifting in the expense of the foreign firm. Consequently, the domestic government has the incentive to subsidize its firm more, the lower the ratio of the domestic marginal cost of production over the foreign one. In the context of the following model, it provides an incentive to identify the lowest cost firm in the market, to be able to compare that with the foreign firms' and then ensure that this receives the optimal policy measure. Thus, the model addressing the identification problem is linked closely with the findings of Neary as he addresses the issue of cost asymmetry between the two monopolies in a strategic trade policy framework. Although the findings apply to the case where a parameter is included to capture the social cost of public funds, they also hold for the case where this parameter is unity and thus the policy measures are a pure transfer. Thus the three

stage model to be described in this paper is an oligopolistic strategic trade model under cost asymmetry, which is reduced to the Neary [61] strategic trade model of a two country Cournot duopoly with a cost asymmetry.

Qiu [67] in a Brander and Spencer framework, where both producing countries are characterised by monopolies, shows that when uncertainty exists in terms of the production cost, a screening mechanism can be used to enable the government allocate the optimal policy measure to the firm, according to its efficiency. He shows that in a two stage game, the welfare optimising mechanism is the introduction of a menu of policies consisting of a subsidy and a lump sum tax to ensure the revelation of the private information regarding its type by the firm. This information, revealed at the end of stage one, is used for the setting of the optimal measure for exporting in the third market. The policy menu chosen, not only allows the government to screen the firm's type, but also signals the type to the rival firm in country 2. The use of a lump sum tax in combination with the subsidy, allows for a separating equilibrium to emerge, as the high cost firm does not choose the higher tax that the low cost firm would incur. A suggestion is incorporated in the paper [67], that the inclusion of this fixed cost can be viewed as a lobbying cost. 'To be viewed as a low-cost firm, the firm must incur a lobbying cost that exceeds some threshold set by the government' as mentioned in footnote 7 (page 336). This paper essentially uses a screening mechanism to ascertain the type of the firm operating in the market of the active policy maker under cost uncertainty. It therefore relates to the lobbying contest, described in the following sections, in the fact that the lobbying contest is attempting to help the policy

maker screen the firms in the market, although in the our framework a number of firms operate in the market, compared to the monopoly in Qiu [67].

This is also related to the argument that the country with the lowest production cost in the monopolistic framework will be providing the highest subsidization level as analysed by de Meza [24]. His finding is summarised in the following: ‘the lower a firm’s marginal cost, the greater the benefit from being able to sell at the initial price. This is why the low-cost country has the incentive to encourage its home firm to expand and therefore pays the highest subsidy’. Relating to the model created in this paper, this finding strengthens the argument that the lowest cost firm ought to be encouraged to compete in the third market framework, through the receipt of a subsidy, instead of incurring the uniform tax imposed as a result of the existence of a number of oligopolistic firms in country one.

Collie and de Meza [17] examine the potential policy measures provided in the case where the goods produced by the two competing countries are instead of strategic substitutes, strategic complements and find that taxes rather than subsidies are the optimal measures. They further their analysis [18] in the examination of the potential influence of the cost level in this framework and show that the absolute value of the policy measure (subsidy or tax) will be higher for a country that has a low cost firm, rather than a high cost one. ‘The general principle is that as the country with the low cost firm has more to gain from intervention, the absolute value of its policy will be greater than that of its higher cost rival’. The higher the subsidy, the higher the credible threat created.

Essentially, the literature proves both that the lowest cost firm receives the highest subsidy and that this allows for the highest rent shifting. Therefore, we could conclude

that in the case of an oligopoly, where the government aims to pick the national champion, it has the incentive to choose the lowest cost firm, and provide the highest subsidy. This would lead to increased rent shifting towards the domestic market.

This chapter of my thesis seeks to analyse such a mechanism that will allow the correct identification of the lowest cost firm in the market. Signalling would serve as such a mechanism following the example of past international trade theory literature. An example of such a paper is Collie and Hviid [19], although their focus is on the use of signaling from the government perspective. The analysis in this chapter will concentrate on the use of signaling as a firm tool. Collie and Hviid [19] under the assumption that the rival foreign firm is not informed of the domestic firm production cost, implying that the foreign firm is the uninformed player, show that the domestic government has the incentive to use a subsidisation policy to signal the competitiveness of its firm. The foreign firm makes its production decision based on its knowledge concerning its own production cost, and its expectation of the domestic one. Thus, the policymaker finds it beneficial to influence these beliefs through the provision of a domestic subsidy, which would imply a low marginal cost. Then the foreign firm would produce a lower level of output to export in the third market, allowing the extraction of higher profits by the domestic one. The level of the subsidy in the case where it is used as a signalling device will be higher than it would be otherwise.

One important aspect of the analysis undertaken is the choice of the correct signalling device that would serve the purpose in the case examined in this thesis. The above mentioned paper uses the policy measure as the signaling device. There is in fact a variety of

ways that the agents use for signaling, such as output, or prices. One important paper using output as a signal is that of Wright [77] who studies the situation where in the case of incomplete information concerning the domestic firm's production cost, the level of output in the first period can serve as a signalling mechanism, both to the rival government and the domestic policymaker of the agent's efficiency, in terms of its cost advantage. The incentive of the low cost firm to imitate a high cost one in order to succeed in receiving a higher subsidy and to induce the foreign firm to produce at a lower level, might actually lead to the reverse results. The government might provide a lower subsidy level than the one without a signal, as it realizes this incentive. The same is the case with the output level of the rival firm. The result therefore is opposite than in the previously discussed model².

Mailath [55] uses prices as signals of the firms' production costs. In a la Bertrand oligopolistic framework, the setting of the price level by each firm serves as a signal of its production cost, which is private information to each firm. Hence in the first period of this dynamic model the firms make price decisions that will signal their cost. Based on these signals their competitors can infer a range of costs and adjust their pricing decisions for the second period. Thus, a firm can influence the pricing choices of its rival firms through the setting of its optimal price in the first period of the game.

In the case examined here however, neither would serve the purpose. In the strategic trade framework, where a protectionist measure is used to increase the profitability of the protected firm in the third market, the setting of the price or quantity level, which would be required in order for either measure to be used as a signal, prior to the setting of the pro-

² In Collie & Hviid signalling increases the policy measure, whilst in Wright it leads to its reduction.

tectionist measure would not be optimal. Nevertheless, firms themselves might provide an answer, through their actions, before the setting of any quantitative measures. The effort of agents to influence the decisions of the principal through the provision of contributions (monetary, informational) has been widely analysed in the general literature. So, this lobbying behaviour can be used by the policymaker in such a way, that the firms will at the end reveal their own costs. We know that firms tend to lobby extensively, and as argued by de Figueiredo [23] 'the more influential instrument in affecting policy outcomes', is lobbying in the form of information, rather than monetary (campaign) contributions. In page 2 of his analysis we read 'Information takes many forms: statistics, facts, arguments, forecasts, threats, signals or some combination of the aforementioned'. From the above, it is evident that lobbying can serve as a signal in the case of asymmetric information, to influence the policymaker's decision to favour the party that expends the highest lobbying effort.

Esteban and Ray [31] in their analysis concerning governments' decision about recourse allocation and the effect of lobbying, show that when the policymaker is uninformed about the productivity of the players, lobbying can serve as an information transmitting mechanism, as the higher productivity players will be the ones lobbying harder. The policymaker then will be able to make the decision concerning whom to favour, after observing the information sent by the agents. Although in the particular case they examine wealth as an influential factor, it is still true that other things being equal, eg wealth, higher productivity players lobby more. This is the principle that the following analysis aims to use.

Thus, the government can manipulate this to its benefit by setting up a lobbying contest, in which the firms will be asked to expend lobbying efforts, and in the end of the

contest, the winner will receive the award in the form of the subsidy. Through their lobbying activity however, the firms will be providing a signal of their ability to the government, and as it turns out, the lowest cost firm will be the one expending the highest effort, and will be the winner.

This approach, the use of lobbying as a means of affecting the government's policy decision, has been widely discussed in the literature. In an international trade context, Pecorino [66] provides an incentive for the existence and participation of lobbies in the setting of trade policies. In his model, subsidisation, which is an expenditure increasing measure for the policy maker, can only be implemented, once lobbying contributions from the interest groups are made, to cover the cost of applying this course of action. When export subsidisation is treated as a revenue seeking process, then it is beneficial for the industry, in terms of higher profits, to choose to provide the necessary means that will ensure a favourable government decision. The higher the contribution level by the industry lobby is, the higher the level of the measure shall be. Consequently, firms could be lead to expend lobbying effort (monetary in this case) in order to influence the decision of the policymaker.

The introduction of lobbying in the strategic trade literature in Moore and Suranovic [57] shows that if the firms have the power to influence the policy measure implementation, the argument for strategic trade policy might be weakened. They describe a situation where the domestic monopoly, has the opportunity to affect the subsidy set by the policy maker, through expending lobbying contributions. Thus the original Brander and Spencer model is extended to allow for the final subsidy received by the firm to be formally set once

the firm has had the opportunity to lobby for a higher rate than the one suggested by the policy maker. The main change in modelling terms is the fact that in stage two the domestic monopoly does not only choose its optimal production level, but also the lobbying effort that maximises its profit function. 'Imperfectly competitive firms may use the excess funds to obtain higher subsidies granted in a strategic trade programme'(page 368). The welfare function consisting of the domestic firm profits minus the subsidy bill in the original model, will now include lobbying costs, as the firms profit function incorporates the lobbying effort that the firm would expend. The inclusion of the lobbying cost in the objective function of the government could imply a reduction in national welfare, and so the optimal level of the subsidy would be decreased (if at all positive). Essentially, the incentive from the government perspective for the setting of a protectionist measure is the shift of rents from the third country; the expending of lobbying effort implies that part of these rents are used to fund the firms' lobbying activity and thus decrease the total amount of profits captured in the third market. A result of the model, as described in page 368 is that 'Even when a positive optimal subsidy exists, the government must lower the announced subsidy to compensate for the effects of lobbying'. Lobbying reduces profits and so the rent shifting argument is weakened. Only if the government has the power to predict the effect of lobbying by including the costs in its objective function, can it provide a lower subsidy to compensate for the loss of welfare due to the existence of influential capability on the firm's side. So, when a positive subsidy does exist, it will be lower than in the B&S model.

The idea that the higher ability firms in an oligopolistic environment will be able to lobby more in order to influence the policymaker's decision, which is vital for our analysis is introduced in Hillman *et al* [42]. Even though the measure used is a quota, the concept resembles the subsidy, in that they both increase the profits of the firm³. It is then the highest ability firm, with the lowest cost and highest profits that will expend the highest lobbying action as it gains the most by the measure implementation. The heterogeneity of the firms in abilities defines their 'comparative advantage in lobbying for protection' activities. In our analysis this is essential, as we require the highest ability player to expend the highest lobbying effort, in order to win the contest and emerge as the optimal national champion. An important difference compared to the model analysed in this chapter of the thesis is the fact that in Hilmann *et al* [42] an oligopoly continues to exist, whereas in our model the oligopoly reduces to a monopolistic framework al'a Brander and Spencer.

In a non-trade context, Tullock [72] mentions that the effort each of the agents will undertake will depend on their success probability, which in turn will depend on the efforts expended by the competing agents. Heterogeneity in this model, which implies different abilities in the setting of the lobbying efforts, will influence the probabilities of success, inducing lower ability players to lobby less. This is consistent with the analysis in later sections of this first chapter, where the aim is to show that lower efficiency players will lobby less than the highest ability player, which will expend the highest lobbying effort and hence will be the winner of the contest.

³ The quota, reduces the amount to be provided, and so increases the price, therefore profits rise. In the case of the subsidy, the cost of production is lowered and so again the difference of the revenue minus the cost for the firm increases. The incentive for lobbying activities is therefore optimal in both situations.

The conclusion of the above paper is reinforced by Nti [65] who focuses on a contest where players are characterised by asymmetric valuations. He suggests that if the players' valuations display asymmetries, then, the 'low valuation players tend to put in less effort because they realise that their winning probabilities are less than average, which encourages high valuation players to attempt to claim the prize with reduced effort' (page 1059).

Therefore, the model analysed in this paper is framed as a 'pick-the-winner' one, where the device used for the emergence of the national champion will be the signal received through the lobbying effort expended by each domestic firm in its attempt to influence the policymaker's decision concerning to whom to award an export subsidy.

The tactic used in the following analysis takes the form of the addition of one more stage to the original two-stage game introduced by Brander and Spencer. This stage facilitates the selection of the most efficient firm as a national champion to compete in the third market.

So, there are n domestic firms characterised by cost asymmetry, each with private information about its cost. Then the most efficient firm will have the incentive in some way to let the government know that it is the one with the lowest production cost. In this way, it will be able to avoid being taxed (whether it is a uniform tax paid by all the firms in the market, or a firm specific tax, if it is thought to be a high cost firm). It will seek to influence the decision of the policymaker, by signalling its efficiency with the expending of lobbying activity. As suggested by Bandyopadhyay et al [3] lobbying efforts expended by the domestic firms create a link between domestic welfare and cost heterogeneity. Domestic welfare on one hand will define the level of subsidisation. The cost heterogeneity on the

other hand determines the share of each of the firms in the domestic market and thus the lobbying contributions it will offer. Their argument is that when market concentration is high, the low cost firms will have a higher incentive to lobby. This stems from the fact that they gain by both the fact that their return is high ⁴ since they receive higher subsidies and that the rent shifting is bound to higher, the higher the policy implemented. They argue that ‘in equilibrium, only the lowest cost domestic firm will expend lobbying effort’ (page 350).

Lobbying, be it in the form of monetary or informational contributions, is characterised by the fact that once made, these contributions are sunk, as those expending these contributions do not receive a refund if they fail to be the prize winners. Thus, there is a strong similarity between the non retrievable lobbying contributions and the forfeit bids of the players under an all-pay auction framework. Therefore, for modeling purposes, the use of an all- pay auction framework is justified, as the main principle underlying this contest type is the lack of recoverability of the players’ bids, once their efforts have been expended (Baye *et al* [4]). When a firm participates in lobbying, the contributions made towards influencing the decision of the policymaker are forfeit and can not be retrieved, even in the case where the firm is not successful.

As shown in Cohen and Sela [16] , in an asymmetric all pay auction set-up where contestants have different values of the award but the same ranking, and the values are common knowledge, then the value of the prize for each player in the auction is vital, as ‘the equilibrium strategies can not be explicitly calculated independently of the players’

⁴ Note that the higher their effort, the higher the subsidy set by the government, as according to their argument ‘the subsidy level will be determined by total lobbying expenditure’

values for the prizes' (page 125). Thus, relating to this chapter of my thesis, the value of the price for each player is an important component in the setting of their equilibrium bidding effort.

Hence, the set up of the model, in this paper is the following: in country one, the operation of an incompletely informed policymaker, the government, is assumed, and a number of domestic firms that exhibit cost heterogeneity. The government is only aware of the existence of different cost levels for the firms but does not know the specific cost of each firm. The policy that the government chooses to implement consists of the provision of a subsidy towards what it considers to be the most efficient of the firms within the market. This policy is announced to the firms each of whom have knowledge of their own cost level and know the distribution function from where the costs are drawn. A lobbying contest is introduced, in which they will develop particular lobbying efforts to signal their efficiency, in order to be able to influence the decision of the policymaker. The firms will try to expend lobbying effort according to their ability, with a view to distinguish themselves from the lowest ability contestants.⁵ So, firms decide upon their lobbying effort levels, and on the base of those, the government decides which the most efficient firm in the market is and awards that firm with the subsidy. After that, this national champion firm will compete internationally in the third market, where it will capture a higher share due to the credible

⁵ They will expend as high an effort as their ability allows, since as is the case in most signalling models the high cost firms will try to pass themselves off as high efficiency ones, in order to cheat the government and get the subsidy, even though optimally, the most efficient one should be the one obtaining the award. This is avoided with the setting of particular incentive compatibility constraints that ensure the truthful revelation of the type of each player through their signal.

threat concerning its production level, created by the subsidy provided by the domestic government.

The basic aim of this paper is the creation of a contest model that will allow the designer to sort the contestants according to their type, or more plainly we seek to create a signalling contest model. What mostly interests us, is that the effort function proves to be a function of the specific ability that the players shall have, in this heterogeneous framework. The correct design of this model will ensure that the most efficient of the players will expend the highest effort and so, by observing the effort, the designer can correctly allocate the award to the highest ability contestant.

1.3 Model

1.3.1 Description

Before embarking on the examination of the identification mechanism that would allow us to distinguish the lowest cost firm, it is essential to illustrate the main models of strategic trade theory that are necessary for the analysis of the lobbying contest model.

Brander and Spencer overview

The first is the seminal model by Brander and Spencer, in which two producing countries compete for their share in the sales and profits derived from a third non-producing country. Production in each of the two countries is undertaken by a monopoly, that receives a subsidy by their respective government in order to assist in the shift of rents towards the country receiving the highest policy measure. Essentially, as Brander described

in his literature review [7], a government can not help its own firm in any other way, aside the provision of a protectionist measure that provides a credible threat and assists in providing the firm with an advantage in terms of the output to be chosen⁶. This is the reason why, when both governments are active in this model, a subsidy war arises, in which each government expends an effort to assist its own firm. The model takes the form of a two stage game, where the first stage consists of the government decision to set the optimal export subsidy for its firm and the second stage involves the optimal production setting for exporting in the third market simultaneously by both firms. Backward induction is used to derive the optimal subsidy level, set by the government that seeks to maximise its welfare function consisting of the profits the monopolistic firm captures in the third market, minus the subsidy bill.

Since for simplicity reasons, the analysis in the following sections is based on the assumption that only the government of the country introducing the lobbying contest will be active, we shall briefly review in terms of functions the steps followed in the Brander and Spencer model.

Using backward induction, the analysis begins with stage 2, describing the setting of the optimal production level, where each of the two producing firms sets its output through the maximisation of a profit function, with the firm in country 1 incorporating the policy measure provided by its protectionistic government. The original Brander and Spencer

⁶ Many authors in the Strategic Trade Theory refer to this advantage as the domestic firm being placed in a Stackelberg leader position. However, as the choice in output in the Brander and Spencer model is simultaneous for both firms, the setting of the subsidy only provides a certain advantage to the protected firm, as the rival will choose a lower output level. This is not however identical with a Stackelberg leader situation, where the output level is chosen in sequence, firstly by the leader and then by the follower.

model is based on the assumption that both firms operate with the same marginal cost c .

Thus the profit functions for the national monopolies in countries 1, 2 are given by:

$$\Pi_1 = P(Q)X_1 - cX_1 + s_1X_1 \quad (1.1)$$

$$\Pi_2 = P(Q)X_2 - cX_2 \quad (1.2)$$

where term s_1 denotes the subsidy provided by the active policy maker, and X_1, X_2 denote the output of firms 1 and 2 respectively.

The first order condition of the objective functions leads to the setting of the optimal output level, as a function of the policy measure provided by the government in country 1 and the cost level of the two firms, $Q = X_1 + X_2 = Q(s_1, c)$.

In the first stage of the game, the policy maker of country 1 sets the optimal policy measure s_1 that maximises her objective function comprising of the profits realised by her national firm competing in country 3 and the subsidy bill:

$$W_1 = \Pi_1 - s_1X_1 \quad (1.3)$$

The first order condition for this function leads to the setting of the optimal protectionist measure s_1 as a function of the firm's production cost $s_1 = s(c)$.

Neary's Model overview

On a similar note, the model introduced by Neary [61] follows the same analysis, however, focuses on the case where the cost of the firm in country 2 differs from the cost in country 1, and also captures the effect of the existence of social costs associated with the provision of a policy measure.

Therefore, the firms maximise profit functions given by:

$$\Pi_1 = P(Q)X_1 - c_1X_1 + s_1X_1 \quad (1.4)$$

$$\Pi_2 = P(Q)X_2 - c_2X_2 \quad (1.5)$$

where term s_1 denotes the subsidy provided by the active policy maker, and X_1, X_2 denote the output of firms 1 and 2 respectively. Parameters c_1 and c_2 denote the marginal costs for firms 1 and 2 respectively.

The first order condition of the objective functions leads to the setting of the optimal output level, as a function of the policy measure provided by the government and the cost level, $Q = X_1 + X_2 = Q(s_1, c_1, c_2)$.

In the first stage of the game, the policy maker of country 1 sets the optimal policy measure s_1 that maximises her objective function comprising of the profits realised by her national firm competing in country 3 and the subsidy bill. As there is now a cost associated with the provision of the policy measure, parameter δ is introduced to capture this effect:

$$W_1 = \Pi_1 - \delta s_1 X_1 \quad (1.6)$$

The first order condition for this function leads to the setting of the optimal protectionist measure s_1 as a function of the firm's production cost and parameter δ : $s_1 = s(c_1, c_2, \delta)$.

Dixit Overview

The third essential model for the analysis of this paper is the oligopolistic strategic trade theory model by Dixit, in which more than one firms in each country produce for

exporting in the third market. In this case a subsidy, which serves to increase the production of the firms for exporting may have adverse effects, as the higher the number of firms in one market, the greater the total output and thus the higher the subsidy bill. If however the number of firms in country 1 is lower than the number of firms in country 2, then the higher subsidy bill will not be covered by the excess in profit shifting. Thus a tax to curb the production of firms would be optimal, bringing the output closer to a cartel output.

In more detail, the first stage of the model as in Brander and Spencer involves the setting of the policy measure by the active government through the maximisation of its objective function. In the second stage the n domestic firms set their optimal production levels. Dixit uses the same assumption in his model as Brander and Spencer and thus all firms in the two markets operate under the same marginal cost c .

The use of backward induction allows the closer examination of the model. Thus, in stage two the firms in country 1 maximise their profit function, including the policy measure set in stage 1, whereas the firm in country 2 maximises a profit function without a protectionist measure.

$$\Pi_{1i} = P(Q)X_{1i} - cX_{1i} + sX_{1i} \quad (1.7)$$

$$\Pi_2 = P(Q)X_2 - cX_2 \quad (1.8)$$

where for equation 1.7, $i = 1, \dots, n$, denotes the n number of firms operating in the market.

The first order condition of the objective functions leads to the setting of the optimal output level by all operating firms, as a function of the policy measure provided by the

government and the cost level, $Q = \sum_{i=1}^n X_{1i} + X_2 = Q(s, c)$. As a result of the cost symmetry between the firms in country 1, the first term $\sum_{i=1}^n X_{1i}$ denoting total production in country 1, can also be written as $\sum_{i=1}^n X_{1i} = nX_1$.

In stage 1 the active policy maker sets the optimal uniform policy measure through the maximisation of its welfare function given by:

$$\begin{aligned} W_1 &= \sum_{i=1}^n \Pi_{1i} - \sum_{i=1}^n sX_{1i} \\ &= n\Pi_1 - nsX_1 \end{aligned} \quad (1.9)$$

The first order condition for this function leads to the setting of the optimal protectionist measure s as a function of the number of firms and the firms' production cost $s = s(n, c)$. As mentioned previously, this firm number will define the sign of the policy measure.

Lobbying Contest Overview

The analysis undertaken in the following sections manages, through the use of a lobbying contest, to transform the oligopolist model to a monopolistic one, thus eliminating any influences arising from the operation of more than one firms in the producing country one.

As stated in Alcade and Dahn [2], a contest describes a situation where players expend irreversible efforts, in order to increase their probability of winning a prize. The literature provides two main ways of modelling contests; firstly, the 'all-pay auction' method, where the prize winner will be the player expending the highest effort and therefore, the probability of winning is one. This type of contest is also known as deterministic. The

second type of contest is based on ‘Tullock’s Rent Seeking Game’ and is also known as a probabilistic contest, as the contestant’s probability of winning, is as described in Che and Gale [12], proportional to her ‘effort’ function.

In the following analysis the former type of contest will be used, as it is the simplest form of contest and as it is deterministic, once the bids have been expended, the player with the highest effort wins with probability one. As the purpose of this analysis is to identify the most efficient player in the market, and the winner is the player expending the highest effort we shall aim to prove that this is the highest ability player.

1.3.2 Assumptions

Consider three countries. Countries 1 and 2 produce output, which they then export to country 3. This allows us to ignore domestic consumer surplus in the national welfare examination undertaken later in section 1.3.4. The market in country 1 is characterised, as per Dixit’s model, by the existence of n firms differing in their production costs. In country 2 only one firm produces output, which then exports to country 3, where the competition between the two nations takes place. The following notation is used; the firm in country 2 produces at a marginal cost c_2 . The cost level for the firms in country 1 is given by c_{1i} , where $i = 1, 2, \dots, n$ and each c_{1i} lies between $[c_L, c_H]$. For future reference the minimum cost in country 1 is given by $c_1^* = c_{1i}^{\min}, i = 1, 2, \dots, n$. Originally in our analysis (status quo), as in Dixit, the firms in country 1 are in receipt of a uniform protectionist measure, a uniform tax, as the number of firms operating in country 1 is greater than that of country

2 ($n > 1$)⁷. These measures are pure transfers, the cost asymmetry, however, implies that the lowest cost firm is mostly burdened by this measure, particularly when the cost level range is high (i.e the actual level of c_H is high), since if it were to emerge as a national champion and compete as a monopolist, it would succeed in capturing a greater share of the profits in country 3. Hence, as per Leahy and Montagna [52], firm specific measures in the form of a firm specific subsidy for the lowest cost firm accompanied by firm specific taxation making production prohibitive for the remaining firms, would solve the inefficiency problem. As mentioned in section 1.2, the lack of certainty in the identification of the lowest cost player creates uncertainty in Leahy and Montagna. Our analysis seeks to overcome both the uniform policy inefficiency and the identification shortcoming. This is achieved through the use of a lobbying contest, which reveals the lowest cost firm and rewards this with a positive subsidy, establishing a monopoly in country 1. The cost of this monopolist will either be equal to the cost of the rival country monopolist, and therefore a Brander and Spencer [8] game arises; or there will be a cost asymmetry between the two rival countries and therefore a model similar to the one described by Neary [61] will emerge. The following analysis will focus on the latter situation, where the two monopolies differ in their cost levels.

The main difference of the Leahy and Montagna [52] model and the one described in the Analysis section below, arises by the fact that the lobbying efforts expended are sunk but not included in the welfare function when the optimal subsidy/award is set. Leahy and Montagna [52] allow for the parameter $\delta > 1$ to capture the social cost of public funds,

⁷ As mentioned previously, in the Dixit model, when the number of firms in country 1 exceeds the number of firms in country 2, then the policy measure will be a tax. Here $n > 1$.

and therefore in their model the policy measures are not pure transfers. In the lobbying contest model described in the following sections, for simplicity, we begin the analysis by assuming this measure to be equal to one and examine the conditions under which the lobbying contest would be welfare enhancing compared to the uniform policy measure. Later, this assumption is relaxed and the analysis is based on $\delta > 1$.

For the lobbying contest, we follow the model of Moldovanu and Sela [58] in combination with the model of Krisna and Morgan [50], with slight modifications to their notation. Several risk-neutral firms engage in a lobbying contest where the prize awarded is a government subsidy, providing monopoly power to the winner, which remains the sole producer in the market. Each contestant has been allocated by nature with an ability parameter, in the form of its constant marginal production cost, denoted by c_{1i} . This implies that the value of winning the award is different for each firm. The ability of each firm is private information to her and it is modeled as an independent draw from an interval $[c_L, c_H]$ according to a distribution function G (with a continuous density denoted by g) which is common knowledge. Note that a low c_{1i} means that i has a high ability and vice versa and therefore c_L denotes the lowest cost/highest ability and c_H the highest cost/lowest cost ability in the distribution interval. Each of the firms in country 1 expends an observable effort L_i , and the function wL_{1i} denotes the cost of participating in the contest, where w denotes the lobbying cost ability parameter for each firm participating in the contest.

Regarding the market conditions, the following analysis aims at identifying the lowest cost firm in the market, and subsequently reduce the oligopolistic framework to a monopolistic one. This requires however that all n firms serve the market in the status quo

and this is ensured by imposing the following assumption: $a > \sum_{i=1}^n c_{1i}$. To also ensure positive production by the firm in country 2, $a > c_2$. As Neary [61] suggests, the policy maker has an incentive to provide protectionist measures to the national champion, when this firm has a cost advantage relative to the foreign firm. Thus for simplification reasons, this is depicted by the following: $c_2 > 2nc_1^*$.

1.3.3 Modelling

The three stage game comprises of the following:

Stage 1- the lobbying contest, where the indirect mechanism used allows for the revelation of the production costs and thus the identification of the lowest cost firm.

Stage 2- in stage two the government, with the knowledge of the production cost of the national champion from stage 1, maximises its welfare function and sets the optimal policy measure. Note that as the identification mechanism used was a lobbying contest, which however only comprises of effort expended not in money terms, the bids from the contest are sunk and do not enter the welfare function intrinsically and thus do not have direct effect on the subsidy provided.

Stage 3- in stage three, the two national firms compete in the third market through the setting of their optimal production levels, knowing that the national monopoly in country 1, where the government is active, receives a direct protectionist measure in the form of an export subsidy⁸.

⁸ This can also be seen as a production subsidy, as we have assumed no domestic consumption.

Note that stages 2 and 3 described above denote stages 1 and 2 in the original Brander and Spencer model where the government sets its optimal policy measure and the firm then sets its optimal production level.

1.3.4 Analysis

Case 1: The Social cost of funding Parameter is Unity ($\delta = 1$)

Lobbying contest

As mentioned previously, the lobbying contest will result to the emergence of the national champion which competes in the third market framework with a foreign rival. As for the purposes of this analysis the cost of these two firms are assumed to differ, the result will be similar to the analysis introduced by Neary [61], who focuses on the case of cost asymmetry between the rival monopolies; the following is a special case application of his analysis, when $\delta = 1$.

Stage 3

Using backward induction, in stage three the firms set their optimal output level, through the maximisation of their profit functions. The national firm of country one, is the lowest cost, as revealed through the direct mechanism, and receives the subsidy that maximises the government's welfare function.

The cost parameter used in the profit denotes the per unit cost of the most efficient firm. For the analysis a representative firm i is used and therefore c_{1i} will be used to provide

the output level function and not the lowest cost c_1^* . The inverse demand is given by

$$P(Q) = a - b(X_1 + X_2) \quad (1.10)$$

where P is the price and $X_1 + X_2 = Q$ is the total production by countries 1 and 2 respectively. Parameters a and b capture the size market. The term s_1 denotes the policy measure received by the firm in country one, where the government is policy active.

The profit function of the firm in country one is characterised by the existence of the protectionist measure, as the government in country one is active. In this scenario, the government of country two is not active and thus the profit function of country two's firm does not contain a subsidy. The profit function of country 1 must take into account the cost of lobbying, although in stage 3 this is sunk.

$$\Pi_1(c_{1i}) = P(Q)X_1(c_{1i}) + s_1X(c_{1i}) - c_{1i}X(c_{1i}) - wL_{1i} \quad (1.11)$$

$$\Pi_2(c_2) = P(Q)X_2(c_2) - c_2X(c_2) \quad (1.12)$$

Thus the profit function comprises of the revenue and cost for the country 2 firm, as seen in equation 1.12. For country 1, the function also includes the subsidy claim of the firm, given by term $s_1X(c_{1i})$ and the lobbying bid, given by wL_{1i} .

The first order condition of the profit functions with respect to the output levels equal⁹:

$$\frac{\theta\Pi_1}{\theta X_1} = \frac{\theta P(Q)}{\theta X_1} X_1 + P(Q) - c_{1i} + s_1 \quad (1.13)$$

⁹ The second order conditions are given by:

$\frac{\theta^2\Pi_1}{\theta^2 X_1} = \frac{\theta^2 P(Q)}{\theta^2 X_1} X_1 + 2P(Q) > 0$
and $\frac{\theta^2\Pi_2}{\theta^2 X_2} = \frac{\theta^2 P(Q)}{\theta^2 X_2} X_2 + 2P(Q) > 0$

$$\frac{\theta \Pi_2}{\theta X_2} = \frac{\theta P(Q)}{\theta X_2} X_2 + P(Q) - c_2 \quad (1.14)$$

Solving for the output levels as functions of the policy measure and the production cost yields:

$$X_1 = \frac{a + c_2 + 2s_1 - 2c_{1i}}{3b} \text{ and } X_2 = \frac{a + c_{1i} - s_1 - 2c_2}{3b} \quad (1.15)$$

Also total production and the price level are given by:

$$Q = \frac{2a - c_{1i} - c_2 + s_1}{3b} \text{ and } P = \frac{a + c_{1i} + c_2 - s_1}{3} \quad (1.16)$$

Note that in equilibrium, where all firms have the incentive to reveal their true costs, c_{1i} , for the lowest cost firm, the winner of the contest in stage 1, the cost will be c_1^* and thus $c_{1i} = c_1^*$ and so

$$X_1^* = \frac{a + c_2 + 2s_1^* - 2c_1^*}{3b} \text{ and } X_2 = \frac{a + c_1^* - s_1^* - 2c_2}{3b} \quad (1.17)$$

Stage 2

In stage 2, the government in country 1, assumed to be the only active in terms of providing a protectionist measure, maximises its welfare function in order to set the optimal subsidy level.

The welfare function, denoted by W_1 , equals:

$$W_1 = \Pi_1 - s_1 X_1 \quad (1.18)$$

Note that the lobbying effort expended by the firms in stage 1 does not enter the welfare function as it is a sunk cost and takes the form of effort rather than actual monetary contributions.

The first order condition yields:

$$\frac{\theta W_1}{\theta s_1} = \frac{\theta \Pi_1}{\theta s_1} - s_1 \frac{\theta X_1}{\theta s_1} - X_1 = 0 \quad (1.19)$$

Substituting in the welfare function, the output levels derived in stage three given by equation 1.15, the following function for the subsidy measure is defined:

$$s_1 = \frac{a - 2c_{1i} + c_2}{4} \quad (1.20)$$

$$\Pi_{1i} = \frac{(a - 2c_{1i} + c_2)^2}{4b} - wL_{1i} \quad (1.21)$$

In equilibrium, where the lowest cost function has been identified through the lobbying contest, as mentioned above : $c_{1i} = c_1^*$, therefore the subsidy equals:

$$s_1^* = \frac{a - 2c_1^* + c_2}{4} \quad (1.22)$$

and the profit function is given by:

$$\Pi_1^* = \frac{(a - 2c_1^* + c_2)^2}{4b} - wL_1^* \quad (1.23)$$

So far the analysis consists of the two stages in the standard Brander and Spencer model. The following stage describes the lobbying contest which is the addition to the standard analysis.

Stage 1

In stage one, the n firms in the market of country one, producing for exports in country three, participate in a lobbying contest that allows the government to detect their efficiency. There are a number of mechanisms that can be used to design the optimal lobbying bidding mechanism in this particular set up, where the policy maker wishes to ascertain the

lowest cost firm in the market. In this particular case we shall use an indirect mechanism, where the lobbying effort of the firms participating in the contest will reveal their type, given by their production cost. An incentive compatibility constraint is imposed, such that in equilibrium, the optimal lobbying effort of the firm is related to its true production cost level. Essentially, as backwards induction is used to solve for the optimal lobbying cost effort, in equilibrium firms will reveal their costs truthfully, in order to extract their maximum profits. Hence, the policymaker can deduce from this equilibrium behaviour, what their true cost is, and in this way can identify the lowest cost player. The national champion will not wish to represent costs lower than the actual levels. To understand this, we can use the revelation principle. In the case examined here, one can think of the indirect mechanism, as a direct mechanism that would involve the truthful revelation by each of the agents of their type to the principal, who in turn will make recommendations on the level of lobbying effort they should expend, given their type. This would have been the equilibrium effort expended by the agent in our indirect mechanism, without the intervention of the principal. This is based on the concept of the revelation principle, which states ‘one can restrict attention, without loss in the designer’s objective, to mechanisms in which (i) the agents report their types completely in a single step up front and (ii) the agents are motivated to be truthful’ (Conitzer and Sandholm [20]). As Myerson and Satterthwaite [60] describe, the importance of the use of a direct mechanism is derived from the fact that for any equilibrium of any direct mechanism there is an incentive compatible direct revelation mechanism that is essentially equivalent.

Proposition 1 *The contest will perform well as a signalling mechanism, as highest ability player (lowest cost firm) will be the winner of the contest and thus the national champion.*

Proof As mentioned above, the type of each of the players is given by their particular per unit production cost, and so the direct mechanism comprises of the revelation of this type by the agent to the principal and then the suggestion of the particular lobbying effort that each player ought to expend, followed by the setting of the optimal subsidy level in the second stage of the game.

The payoffs for each of the firms entering the contest are given by:

$$\Pi_{1i}(c_{1i}) = \begin{cases} P(Q)X_{1i} + s_1(c_{1i})X_{1i} - c_{1i}X_{1i} & \text{if } L_{1i} > \max_{j \neq i} L_{1j} \\ -wL_{1i}(c_{1i}) & \\ -wL_{1i}(c_{1i}) & \text{if } L_{1i} < \max_{j \neq i} L_{1j} \end{cases} \quad (1.24)$$

The first line gives the payoffs-profits of the firm that wins the award and so proceeds to the international competition stage, whereas the second line provides us with the payoffs of the non-winning firm that only incurs the cost of entering the contest and does not produce for exporting at the international level. In terms of notation, L_{1i} denotes the lobbying effort that player i will expend as a bid.

The maximisation problem for contestant firm i is given by the following expression, which describes the profit for the firm which is the sum of the potential profit or loss depending on the probability of the firm being the winner:

$$\begin{aligned} & \text{Max}[P(Q)X_1(c_{1i}) + s(c_{1i})X_1(c_{1i}) - c_{1i}X(c_{1i})] \text{Pr ob}(\text{winning}) + \\ & [-wL(c_{1i})] \text{Pr ob}(\text{not winning}) \end{aligned} \quad (1.25)$$

Where the probability of winning is given by:

$$1 - G(c_{1i}) \quad (1.26)$$

Player i may try to report a different cost efficiency than her actual level, in order to influence the outcome. Denoting the reported cost level as \bar{c}_{1i} and the actual c_{1i} then the maximisation problem for the firm i participating in the contest is:

$$Max[P(Q)X_1(c_{1i}) + s(\bar{c}_{1i})X_1(c_{1i}) - c_{1i}X(c_{1i})][1 - G(c_{1i})]^{n-1} - wL(\bar{c}_{1i}) \quad (1.27)$$

Suppose there exists a strategy $L^* = L(\bar{c}_{1i})$ such that

$$prob(L_{1i}^* > L_{1j}^*) = prob(c_{1i}^* < c_{1j}^*) = 1 - G(c_{1i}) \quad (1.28)$$

The first order condition with respect to \bar{c}_{1i} :

$$\begin{aligned} & \left[\frac{\partial P(Q)}{\partial \bar{c}_{1i}} X_1(c_{1i}) + \frac{\partial X_1(c_{1i})}{\partial \bar{c}_{1i}} P(Q) + \frac{\partial s(\bar{c}_{1i})}{\partial \bar{c}_{1i}} X_1(c_{1i}) + \right. \\ & \left. \frac{\partial X_1(c_{1i})}{\partial \bar{c}_{1i}} s(\bar{c}_{1i}) - \frac{\partial c_{1i}}{\partial \bar{c}_{1i}} X_1(c_{1i}) - \frac{\partial X_1(c_{1i})}{\partial \bar{c}_{1i}} c_{1i} \right] [1 - G(c_{1i})]^{n-1} - \\ & (n-1)[1 - G(c_{1i})]^{n-2} \left[\frac{\partial G(c_{1i})}{\partial \bar{c}_{1i}} \frac{\partial c_{1i}}{\partial \bar{c}_{1i}} \right] [P(Q)X_1(c_{1i}) + s(\bar{c}_{1i})X_1(c_{1i}) - c_{1i}X_1(c_{1i})] \\ & - \frac{\partial w}{\partial \bar{c}_{1i}} L(c_1) - \frac{\partial L(c_1)}{\partial \bar{c}_{1i}} w \end{aligned} \quad (1.29)$$

In equilibrium the firm has no incentive to pretend to be someone else and so the reported cost level equals the actual cost level $\bar{c}_{1i} = c_{1i}$.

Therefore:

$$\begin{aligned} & \left[\frac{\partial P(Q)}{\partial c_{1i}} X_1(c_{1i}) + \frac{\partial X_1(c_{1i})}{\partial c_{1i}} P(Q) + \frac{\partial s(c_{1i})}{\partial c_{1i}} X_1(c_{1i}) + \right. \\ & \left. \frac{\partial X_1(c_{1i})}{\partial c_{1i}} s(c_{1i}) - \frac{\partial c_{1i}}{\partial c_{1i}} X_1(c_{1i}) - \frac{\partial X_1(c_{1i})}{\partial c_{1i}} c_{1i} \right] [1 - G(c_{1i})]^{n-1} \\ & - (n-1)[1 - G(c_{1i})]^{n-2} g(c_{1i}) [P(Q)X_1(c_{1i}) + s_1(c_{1i})X_1(c_{1i}) - c_{1i}X_1(c_{1i})] \end{aligned} \quad (1.30)$$

$$-\frac{\partial w}{\partial c_{1i}}L(c_{1i}) - \frac{\partial L(c_{1i})}{\partial c_{1i}}w = 0$$

As the lobbying cost ability parameter is assumed not to depend on the cost level,

$\frac{\partial w}{\partial c_{1i}} = 0$. Thus, rearranging, the following equation is derived

$$\begin{aligned} \frac{\partial L(c_{1i})}{\partial c_{1i}} = & \frac{1}{w} \left\{ X_1(c_{1i}) \left[\frac{\partial P(Q)}{\partial c_{1i}} + \frac{\partial s_1(c_{1i})}{\partial c_{1i}} - 1 \right] + \frac{\partial X_1(c_{1i})}{\partial c_{1i}} H(c_{1i}) \right\} [1 - G(c_{1i})]^{n-1} \\ & - (n-1) [1 - G(c_{1i})]^{n-2} g(c_{1i}) \tilde{\Pi}(c_{1i}) \end{aligned} \quad (1.31)$$

where $H(c_{1i}) = P(Q) + s(c_{1i}) - c_{1i}$ and $\tilde{\Pi}(c_{1i}) = [P(Q) + s(c_{1i}) - c_{1i}]X(c_{1i})$

Note that from stage 2, where the optimal subsidy level was defined, we obtain :

$$\frac{\partial s(c_{1i})}{\partial c_{1i}} = -\frac{1}{2} \quad (1.32)$$

The least efficient player has a zero probability of winning the contest and therefore the boundary condition is given by:

$$L(c_H) = 0 \quad (1.33)$$

The lobbying effort expended by player i is therefore obtained through:

$$L_i = \int_{L_i}^0 dt = - \int_{c_i}^{c_H} \frac{\partial L(c_i)}{\partial c_i} \quad (1.34)$$

Thus:

$$L_{1i}^* = - \int_{c_{1i}}^{c_H} \left[\{X(t) \left[\frac{\partial P(Q)}{\partial t} - \frac{3}{2} \right] + \frac{\partial X(t)}{\partial t} H(t) \} [1 - G(t)]^{n-1} w^{-1} dt \right. \quad (1.35) \\ \left. + \int_{c_{1i}}^{c_H} \tilde{\Pi}(t)(n-1)[1 - G(t)]^{n-2} w^{-1} dt \right]$$

As mentioned above, the cost of the most efficient firm in the market is denoted by c_1^* , therefore the above expression takes the form:

$$L_1^* = - \int_{c_1^*}^{c_H} \left[\{X(t) \left[\frac{\partial P(Q)}{\partial t} - \frac{3}{2} \right] + \frac{\partial X(t)}{\partial t} H(t) \} [1 - G(t)]^{n-1} w^{-1} dt \right. \quad (1.36) \\ \left. + \int_{c_1^*}^{c_H} \tilde{\Pi}(t)(n-1)[1 - G(t)]^{n-2} w^{-1} dt \right]$$

At this point in the analysis, we wish to address the issue of the effect the ability parameter has on the effort function. The aim of the model is to supply a way of sorting the players according to their abilities. The expectation is that a decrease in the expended effort takes place as the player's ability decreases (i.e. the ability parameter increases in value).

The relationship between the ability parameter, the production cost of each firm and the lobbying effort function is examined. An increase in effort is anticipated, as the ability parameter rises (i.e. the value of the ability parameter is reduced: firms produce at a lower cost level). This analysis is assisted by the inspection of the derivative of the lobbying effort function with respect to the ability parameter. We only need to show that the sign of the function is negative.

$$\frac{\partial L(c_{1i})}{\partial c_{1i}} =$$

$$\begin{aligned}
& \underbrace{\frac{1}{w_+} \left\{ X_1(c_{1i}) \left[\underbrace{\frac{\partial P(Q)}{\partial c_{1i}} + \frac{\partial s_1(c_{1i})}{\partial c_{1i}} - 1}_{-} \right] + \frac{\partial X_1(c_{1i})}{\partial c_{1i}} H(c_{1i}) \right\} [1 - G(c_{1i})]^{n-1}}_{-}^{[1]} \\
& - \frac{1}{w_+} \underbrace{(n-1) [1 - G(c_{1i})]^{n-2} g(c_{1i}) \tilde{\Pi}(c_{1i})}_{+}^{[2]} < 0
\end{aligned} \tag{1.37}$$

The first term [1] has a negative sign, due to the negative relationship between the price and cost level and the output and cost level. The second term [2] is positive, however the negative sign in front of it makes this negative in value. The conclusion therefore is that the lower the cost level (ability parameter) the higher the lobbying effort each firm will expend. The end of the game will therefore find the highest ability player as the winner of the contest **OED**.

Welfare Comparison

The above analysis, as stated in the introduction, has aimed to provide a solution for the identification problem for the lowest cost firm, as stated in the analysis by Leahy and Montagna [52]. In extension it also provides a solution to the uniform policy measure provision problem, in the Dixit [25] framework, when firms have asymmetric costs, as also examined by L&M [52]. The approach we used, has successfully lead to the identification of the lowest cost firm and the creation of a national champion. This is the sole recipient of a positive policy measure the only firm from country 1 which produces and competes in the third market.

It is essential, however, at this point to turn to the examination of the welfare levels, resulting from the intervention described above, in the form of the creation of the lobbying

contest. This will establish whether the Lobbying contest intervention, aside from solving the identification problem also leads to welfare enhancement compared to the a la Dixit uniform policy measure provision under the asymmetry assumption. The welfare level from the lobbying contest, therefore the monopolistic Brander and Spencer framework under cost asymmetry welfare level, will be compared with the welfare level of the a la Dixit asymmetric oligopolistic model.

The welfare levels for the following analysis are denoted by W^D for the a la Dixit oligopolistic model with cost asymmetry and W^L for the lobbying contest intervention.

Proposition 2 *The welfare levels for the two possible situations as described above are given by:*

$$W^L = \frac{(a - 2c_1^* + c_2)^2}{8b} \quad (1.38)$$

$$W^D = \frac{[n(a + c_2) - 2\sum_{i=1}^n c_{1i}]^2 + 8n[n\sum_{i=1}^n (c_{1i})^2 - (\sum_{i=1}^n c_{1i})^2]}{8bn^2} \quad (1.39)$$

Proof. In Appendix A.1 ■

We now turn to the comparison of the two welfare levels to establish whether and under what conditions the lobbying contest intervention and the creation of the national champion is welfare enhancing. Therefore the comparison of welfare under the Lobbying Contest regime versus the a la Dixit, takes the following form:

$$W^L - W^D = \frac{(a - 2c_1^* + c_2)^2}{8b} - \frac{[n(a + c_2) - 2\sum_{i=1}^n c_{1i}]^2 + 8n[n\sum_{i=1}^n (c_{1i})^2 - (\sum_{i=1}^n c_{1i})^2]}{8bn^2} \quad (1.40)$$

Proposition 3 *The lobbying contest intervention is welfare improving under certain market and cost conditions.*

Proof. In Appendix A.2 ■

The main observation in support of this model is that the Lobbying Contest scheme, in which only one firm receives governmental assistance, in the form of the subsidy, compared to the status quo situation, where all firms receive the policy measure, is welfare improving when the market size served is high and the cost advantage of the national champion exceeds a certain value, which increases with the number of oligopolistic firms operating in the market under the a'la Dixit model, as can be observed by the analysis of the simplifying examples of Appendix A.2.

Case 2: The Social Cost of Funding Parameter is greater than one ($\delta > 1$)

Lobbying Contest

As mentioned previously, the lobbying contest will result to the emergence of the national champion which competes in the third market framework with a foreign rival. As for the purposes of this analysis these are assumed to differ in their production costs, the result will be similar to the analysis introduced by Neary [61], particularly for the setting described below, where the social cost of funding is greater than one.

Stage 3

Stage 3 is not directly affected, when the social cost of funds exceeds unity and therefore in equilibrium all firms have the incentive to reveal their true costs, c_{1i} . For the lowest cost firm, the winner of the contest in stage 1, the cost will be c_1^* and thus $c_{1i} = c_1^*$

and so the output levels are the same as described by equation 1.17:

$$X_1^* = \frac{a + c_2 + 2s_1^* - 2c_1^*}{3b} \text{ and } X_2 = \frac{a + c_1^* - s_1^* - 2c_2}{3b} \quad (1.41)$$

Stage 2

In stage 2, the government in country 1, assumed to be the only active in terms of providing a protectionist measure, maximises its welfare function in order to set the optimal subsidy level.

In this set up, the pure transfer policy measure assumption is relaxed and the parameter $\delta > 1$, is introduced to capture the social cost of funds. Thus the welfare function, denoted by W_1 , equals:

$$W_1 = \Pi_1 - \delta s_1 X_1 \quad (1.42)$$

Note that the lobbying effort expended by the firms in stage 1 does not enter the welfare function as it is a sunk cost and takes the form of effort rather than actual monetary contributions. Similarly to the analysis described by equations 1.18-1.22, the equilibrium level of the policy measure derived for the lowest cost firm is given by:

$$s_1^* = \frac{(a - 2c_1^* + c_2)(3\delta - 4)}{(8 - 12\delta)} \quad (1.43)$$

Note that the measure set in equation 1.43, is a form of the optimal policy measure obtained by Neary [61] for the case of an international Cournot duopoly where both the production costs of the rival firms differ and a social cost of public funds exists. Note that, confirming his findings, the policy measure/award in equation 1.43 is a subsidy if the parameter $\delta < \frac{4}{3}$.

Hence, depending on δ , the lowest cost firm may be taxed in this set up, however the tax paid will be lower than the tax under the uniform policy measure regime. The profit

function, equivalent to equation 1.23 is given by:

$$\Pi_1^* = \frac{(a - 2c_1^* + c_2)^2 \delta^2}{2b(3\delta - 2)} - wL_1^* \quad (1.44)$$

Stage 1

In stage 1, following the same analysis as in equations 1.24-1.34 for the case of $\delta > 1$, we obtain the following expression for the equilibrium lobbying effort of the lowest cost firm:

$$\begin{aligned} L_1^* = & - \int_{c_1^*}^{c_H} \left[\{X(t) \left[\frac{\partial P(Q)}{\partial t} - \frac{6\delta}{12\delta - 8} \right] + \frac{\partial X(t)}{\partial t} H(t)\} [1 - G(t)]^{n-1} w^{-1} dt \right. \\ & \left. + \int_{c_1^*}^{c_H} \tilde{\Pi}(t)(n-1)[1 - G(t)]^{n-2} w^{-1} dt \right] \end{aligned} \quad (1.45)$$

As the sign of derivative of the lobbying effort function with respect to the cost ability parameter is negative, as seen in the following equation, the lobbying contest performs well and reveals the lowest cost firm in the market.

$$\begin{aligned} \frac{\partial L(c_{1i})}{\partial c_{1i}} = & \underbrace{\frac{1}{w} \left\{ X_1(c_{1i}) \left[\underbrace{\frac{\partial P(Q)}{\partial c_{1i}} - \frac{6\delta}{12\delta - 8}}_{-} \right] + \frac{\partial X_1(c_{1i})}{\partial c_{1i}} H(c_{1i}) \right\} [1 - G(c_{1i})]^{n-1}}_{-} \quad (1.46) \\ & - \frac{1}{w} \underbrace{(n-1) [1 - G(c_{1i})]^{n-2} g(c_{1i}) \tilde{\Pi}(c_{1i})}_{+} < 0 \end{aligned}$$

Welfare Analysis

In this subsection we shall endeavour to examine whether the inclusion of a parameter $\delta > 1$, capturing the social cost of public funds, as per the Leahy and Montagna [52] model alters the conclusion in the welfare analysis for $\delta = 1$.

The welfare levels for the following analysis are denoted by W^D for the a la Dixit oligopolistic model with cost asymmetry and W^L for the lobbying contest intervention.

Proposition 4 *The welfare levels for the two possible situations as described above are given by:*

$$W^L = \frac{\delta^2(a - 2c_1^* + c_2)^2}{(3\delta - 2)8b} \quad (1.47)$$

$$W^D = \frac{\delta^2[n(a + c_2) - 2\sum_{i=1}^n c_{1i}]^2 + 4[2\delta(n + 2) - 4][n\sum_{i=1}^n (c_{1i})^2 - (\sum_{i=1}^n c_{1i})^2]}{8b[(n + 2)\delta - 2]} \quad (1.48)$$

Proof. In Appendix A.3 ■

We now turn to the comparison of the two welfare levels to establish whether and under what conditions the lobbying contest intervention and the creation of the national champion is welfare enhancing. Therefore the comparison of welfare under the Lobbying Contest regime versus the Dixit, takes the following form:

$$W^L - W^D = \frac{\delta^2(a - 2c_1^* + c_2)^2}{(3\delta - 2)8b} - \frac{\delta^2[n(a + c_2) - 2\sum_{i=1}^n c_{1i}]^2}{8b[(n + 2)\delta - 2]} - \frac{[2\delta(n + 2) - 4][n\sum_{i=1}^n (c_{1i})^2 - (\sum_{i=1}^n c_{1i})^2]}{8b[(n + 2)\delta - 2]} \quad (1.49)$$

Proposition 5 *The lobbying contest intervention is welfare improving under certain market and cost conditions, when $\delta > 1$.*

Proof. In Appendix A.4 ■

The comparison of these two welfare levels yields threshold values for the cost of the foreign firm, which when exceeded may not lead to welfare improvements. This can be interpreted by the fact that under the assumption of social cost, there is a requirement for the policy maker to raise funds from other industries in order to pay the subsidisation bill. However, the higher the cost advantage of the national champion competing in the third market, the higher the incentive for the policy maker to provide the subsidy. There is however a threshold value for the cost of the foreign firm, that if exceeded, the subsidy bill may prove too costly for the remaining industries.

Thus, both in the case, where the $\delta = 1$ and $\delta > 1$, the lobbying contest can be welfare enhancing, when certain conditions regarding the market size and the cost level are met.

1.4 Concluding Remarks

In the above chapter, a solution has been provided, to the problem of the inability of the policymaker to identify the cost advantage firm in the domestic market, when she is interested in providing a strategic trade policy measure.

We have shown that through the use of a contest, the firms will expend efforts according to their abilities. Consequently, the highest effort will be that of the lowest cost firm,

and so the winner of the contest will be the firm that the government seeks to reward. The exertions of the participants in the contest therefore serve as signals of the particular ability of the players, and so the winner will be the highest ability one. This will be the most advantageous option for the government to set as the national champion that will compete in the international level against a single foreign firm.

The use of this model facilitates the reduction of the a la Dixit oligopolistic asymmetric cost strategic trade model to a monopolistic one, which will either entail a cost asymmetry between the rival country monopoly firms or a cost symmetry. This will depend on the cost of the national champion compared to the cost of the foreign rival. For the purposes of this analysis, we have focused on the case where the national champion has a cost advantage compared to the foreign rival. The welfare levels realised by such a move are greater than the welfare in the case of per unit subsidy provision for all domestic firms competing in the third market, under certain conditions regarding the cost levels in the two producing countries and the market size.

Chapter 2

Cooperation In Brander and Spencer

2.1 Introduction

The seminal paper by Brander and Spencer [8] was among the first describing the use of subsidization as a strategic trade tool. Their main finding involves the use of subsidies by policy makers as a credible threat device to bring their own domestic firm in the Stackelberg leader position. This however, leads to a Prisoner's dilemma situation, in which even though both countries would be better off without the use of any protectionist measure, they both continue to provide them. It is assumed in the paper, that any co-operational moves, such as the bilateral reduction of the subsidy measures can not take place. Still they briefly consider the effect of such a scheme, in which co-operation takes place only in the policy maker decision level (stage 1), and results in the setting of taxes that would lead to a two-firm monopoly output level set by the firms in the production stage.

This paper analyses cooperation schemes that can potentially arise in a strategic trade policy framework as introduced by Brander and Spencer [8]. The term cooperation describes the potential agreement between players, governments or firms, to either set subsidies jointly in the former case, or produce together as a monopoly, where the low cost firm undertakes all production, in the latter. So, three cases are examined, one in which the governments decide to cooperatively maximise their objective functions and thus set the subsidies at lower levels than those prevailing in the non co-operational case. The two

remaining cases involve the effort of firms to cooperate and in this way create a single international monopoly and the decision of governments to either not cooperate or jointly maximise their objective functions to set their optimal protectionist measures. In both cases, these measures turn out to be taxes, as the firms deviate from their roles as national champions.

So far in the strategic trade theory literature, there has been no analysis of potential cooperation approaches. Only Brander and Spencer allow for cooperation and depending on the consumption levels in the two exporting countries, the policy measures would emerge to be positive or negative. Cooperation in the Brander and Spencer framework takes place in only the government level, as they allow cooperation solely at the policy maker level. In the following paper, the aim is to relax this assumption and examine what the effect will be if co-operation was allowed, firstly among governments and then among firms. In Brander and Spencer [8], firms can not influence the governments' decision and their only function is production. In this particular analysis, they will be able to create co-operational arrangements in the form of co-production agreements, through which only the most cost efficient firm will produce, but both will share the profits from such an endeavour. This is in close proximity to the creation of a merger between the two monopolistic firms, even though the autonomy of both partners remains.

One of the main results of the analysis of this chapter is that under certain conditions, cooperation at both the government and the firm level, is supported by the policy makers, as this leads to the maximum attainable welfare levels. These conditions, related to consumption patterns, include the situation where the cost disadvantaged country consumers

consume its own output in its entirety, and the cost advantaged country none, when the cost asymmetry does not exceed a certain value. The most prominent result is that welfare is always higher under co-operational agreements.

The rest of the chapter proceeds as follows; Section 2.2 provides an overview of the related literature, followed by the model analysis in Section 2.3, which includes the analysis of the three possible cooperational agreements under both a constant and decreasing marginal cost framework. Section 2.4 concludes. Supporting proofs to propositions are included in Appendix B.

2.2 Literature Review

As the discussion of the following paper analysis is mainly based on the relaxation of one of the main assumptions made by Brander and Spencer [8], it is essential to examine similar past approaches.

Following the introduction of the seminal above mentioned paper, many articles have emerged contradicting these findings, most of them based on the relaxation of the Brander and Spencer underlying assumptions. To mention few, firstly, using the same market structure, the relaxation of the symmetry assumption, as Neary [61] shows, implies that the provided protectionist measure is an increasing function of the rival's production cost and a decreasing of the country's own cost, when the optimal policy measure is positive. This analysis is based on the assumption that a social cost may be involved in the provision of the optimal policy measure, which can prove to have a positive or negative sign, depending on the cost.

This relationship between the policy measure and the production costs of the rivals is closely linked to the result of de Meza's paper [24] in which he concludes that the country with the lowest production cost will be providing the highest subsidisation level and the result from Collie and de Meza [18] that find the policy measure provided by a country with a low cost level to be lower in absolute value than that of a country with a high cost. If the governments place different weights on the subsidy bill, the profits and the consumer's surplus differ, then their difference will define the optimal policy measure and thus welfare shown in Neary [61]. If the assumption concerning the number of competing firms is relaxed, and more than one firm is allowed to operate in the particular industry in each country, then their specific number in each country defines the optimal measure. Dixit [25] examined this particular setting and concluded that positive subsidies will be provided for a country's firms only if their firms are less in number than the rival country's, which in turn will be asked to pay a tax, when both policy makers are active. In the case where multiplicity exists in the industries operating in the two markets and the labour force is divided in two groups, skilled and unskilled, then if there is substitutability among the two groups between industries, the subsidisation incentive remains positive as shown in Dixit and Grossman [27]. If the change concerns the nature of the particular market structure, i.e. instead of Cournot, the firms compete à la Bertrand, then the analysis leads to the setting of taxes as the optimal measures, as analysed in Eaton and Grossman [28].

To my knowledge, no analysis has yet taken place based on the relaxation of the assumption concerning cooperation. According to the analysis in their paper, Brander and Spencer [8], show that when such a scheme is permitted, depending on the consumption

levels of the consumers in the two exporting countries, the policy measures would turn out to be positive or negative. This would imply co-operation in only the government level. This chapter aims to relax this assumption and analyse the effect of co-operation, firstly on a policymaker level and then between firms. In Brander and Spencer [8], firms only act as producers and can not affect the governments' decisions. Here, however, they will be able to create their own co-operational agreements. In this particular analysis, the only type of co-operation allowed between firms is a co-production agreement. This will lead to production undertaken by the cost efficient firm, although both firms will share the profits from such an endeavour. This is in close proximity to the creation of a merger between the two monopolistic firms, even though both partners maintain their autonomy.

Examining the merger literature, related with strategic trade, it is claimed that there exists a degree of substitutability among competition and strategic trade. In particular, in Horn and Persson [44] it is suggested that 'a potentially important aspect of merger policy in an international contest is that the design of the policy vis-à-vis international mergers may influence the 'terms of trade' mergers.' The above implies that it may turn out that a government may choose competition policy instead of strategic trade and vice versa.

To achieve cooperation between firms and governments, incentives must exist to induce the players to agree. In terms of the incentives for merger schemes related to production cooperation, Horn and Persson [43] examine them from both the private and the social point of view. The results they come to are that 'private and social incentives for mergers may differ for weak merger synergy but converge if synergy is strong'. This implies that under high levels of cost asymmetry between firms (i.e. the greater the synergy once the

merger is formed) the incentive to merge in both a private and a social perspective is great. Then the private incentive to merge might be in conflict with the social incentive, as firms gain in profit terms from the merger, however the price increase from the merger would harm consumers more than the firms would profit from this merger.

A co-production agreement in this static framework can be seen as a two firm merger. The issue is addressed in detail in Huck and Konrad [49]. The important point to be mentioned is that in their paper ‘firms and not governments make merger decisions and thereby affect governments’ future decisions about strategic trade policy’. So, profit and not welfare is the objective function of the decision makers in the first stage. They use an endogenous merger approach as in Horn and Persson [43] in which side payments are used to solve the free rider problem created by mergers in countries with more than one firms. Assuming that negotiations are plausible among firms they reach the conclusion that bargaining will take place until only one firm will serve the entire market and no subsidies will be provided by either of the producing nations.

The reason behind the use of the two country-two firm model is the fact that it would be more plausible for two firms to bind themselves in such an agreement. A larger number of firms would reduce the probability of such an agreement to be reached and sustained. It has also been proved in the literature that a merger would be profitable only if the firms would agree to merge in a monopoly, as in any other situation a ‘free-rider problem’ would be created (Salant, Switzer and Reynolds [71]). Also, in Horn and Persson [44] as mentioned above, a decision in the competition policy level may affect the terms of trade. Thus, Horn and Persson [43], departing from their two country-four firm model and through the

introduction of the simpler case of a two country-two firm Cournot oligopoly, suggest the examination of the possibility of a 'duopoly-to-monopoly' reduction merger between a domestic and a foreign firm. 'Whether or not this merger will increase domestic welfare depends partly on the division of the monopoly profit it yields. The firms then may realize that the domestic competition authority will not accept the merger, unless a sufficiently large fraction of the profit accrues to the domestic owner, and will thus find it worthwhile to form their agreement so that it is acceptable to the competition authority. Conducted in this manner, the merger policy thus takes on a strategic role similar to that of strategic trade policy.' In this again the role of the firm in terms of influencing the decision of the policymaker in the strategic trade policy framework is analysed.

One paper that examines merger decisions in a strategic trade policy framework is Leahy [51] in which the game consists of three stages. The exact sequence of these stages differs depending on whether the government can commit to the policy measure before the merging decision is reached or not. The government however 'is better off if it does not commit to its policy before the firms decide whether they merge or not'.

In this paper, three potential co-operational agreements are analysed, namely **joint welfare maximisation**, in which the governments only choose to cooperate, through the maximisation of a joint welfare function for the setting of the optimal policy measures, **co-production**, in which the duopoly that serves the third market becomes a monopoly when the firm of each country enters an agreement for production to be undertaken by the cost efficient of the two firms and lastly the combination of the two above co-operational methods, **joint welfare maximisation combined with coproduction**, in which both the

governments and the firms maximise joint welfare functions. This analysis is completed in three separate sections, that include a general overview, followed by a more detailed analysis involving the use of linear function examples for illustration and simplification purposes. The first part of the analysis is based on the assumption of constant marginal costs. The focus is on the analysis of co-operational agreements, when consumption is allowed for in the producing countries, however a special case, not including consumption, as per the original Brander and Spencer model is also briefly described. The potential outcomes of these agreements are analysed, focusing on the possible consumption levels of the countries. Decreasing marginal costs are then introduced in the analysis and a simple model illustrates the result deviations from the constant marginal costs analysis. The last section concludes.

2.3 Model

2.3.1 Assumptions

The world is assumed to consist of three countries, 1, 2 and 3. Countries 1 and 2 undertake the production of goods and export to country 3's large market, which acts solely as the importer. Each of the producing countries contains one firm, indexed by country: firms 1 and 2, producing for internal consumption and to export set output at a level that includes the provision of a per unit export subsidy set by the governments of countries 1 and 2 respectively. The firm in country 2 is assumed to have a lower fixed marginal cost than country 1's firm. This is related to the analysis of Neary [61], who examines the case of

the existence of asymmetry ‘between the home and foreign costs of production’. Later the analysis will include the examination of the existence of decreasing marginal costs. This cost asymmetry ensures that the lowest cost firm receives both a higher subsidy and a higher share of the profits captured in the third market, as per de Meza [24] and Collie and de Meza [18].

The analysis of this chapter of my thesis is essentially based on the cost asymmetry assumption between the two rival firms, which is an extension of the original Brander and Spencer model and was analysed by Neary [61], when the two rival countries consume none of their production. As Brander and Spencer [8] in their symmetric analysis describe the possibility of cooperation, and also introduce consumption in the two rival countries, which is useful for the purposes of the following analysis, we shall be using the term Brander and Spencer with cost asymmetry when referring to the no cooperational sections. The Brander and Spencer model with cost asymmetry when no consumption takes place in the producing countries, which is a special case examined later on, was however analysed by Neary [61] both in the case when there is a social cost associated with the provision of the optimal policy measure and when there is not.

The concept of co-operation describes the potential agreement between players, governments or firms, to either set subsidies jointly or produce together as a monopoly respectively. Thus the three cases to be analysed include the decision of governments to cooperate, maximising a joint welfare function, the decision of firms to cooperate maximising a joint profit function and lastly the case where both sets of players cooperate by setting both the policy measures and the production level cooperatively.

For the analysis of the **joint welfare maximisation** (J) agreement, where only the two principals, the governments, choose to cooperate, a two-stage game is considered. In the first stage, the two governments set the policy measures cooperatively and in the second stage, the firms set the output level. This analysis follows Brander and Spencer [8]. The analysis of the **coproduction** (c) agreement, when the two national monopolies, the agents, choose to embark on an agreement to jointly produce at a two firm monopoly level, whilst claiming protectionist measures by their respective governments and the combinational agreement of **joint welfare maximisation and coproduction** (Jc), where both governments and firms maximise joint functions, includes one more stage which involves bargaining between the firms. The three-stage game consists of the setting of the policy measures in stage one, given by the maximisation of the individual welfare function for each policy maker in the first situation and the maximisation of a joint welfare function for the latter case. Stage two involves the bargaining over the combined profits and the final stage, the setting of output at the two firm monopoly level.

The co-production type agreement involves three stages. The first involves the setting of the optimal non-cooperative policy measure, as this type of agreement does not involve government cooperation. The second stage involves the bargaining over profits by the two producing firms. There are three potential profit functions for the firms, depending on the level of protectionist measure claimed by the firms; (i) where only the low cost producing firm claims the measure by its own government, (ii) when both firms claim a share of the total production and therefore aim at receiving a protectionist measure level according to their production and (iii) when both claim full ownership of the total production and falsely

try to claim protectionist measures for the same produced output twice. Here, we believe that the last case is the most interesting one, and therefore focus the analysis on this.

Country 3's inverse demand function is given by:

$$P(Q^i) = a - bQ^i \quad (2.1)$$

Where Q^i is the total produced output in each situation i ($i = [NC, J, c, Jc]$). Parameter a can be interpreted in terms of the size of the market.

The cost of production is given for each firm j , by the following expression:

$$C_j(Q_j^i) \quad (2.2)$$

The cost functions for the first part of this analysis based on the assumption of constant marginal costs are given by:

$$C_j(Q_j^i) = c_j Q_j^i \quad (2.3)$$

Where Q_j^i denotes the output produced by firm j and c_j denotes the constant marginal cost for firm j ($j = 1, 2$). Thus

$$MC_j = c_j \quad (2.4)$$

As mentioned earlier, the existence of a cost asymmetry between the two producing firm implies that $c_2 < c_1$.

The assumption of constant marginal costs will be relaxed in section 2.3.5 to allow for the existence of decreasing marginal costs. Then, for illustrative purposes, the costs function will be given by the following expression, as described in Fisher [34]:

$$C_j(Q_j^i) = c_j Q_j^i + \frac{1}{2} d_j (Q_j^i)^2 \quad (2.5)$$

Therefore the marginal cost is given by

$$MC_j = c_j + d_j Q_j^i \quad (2.6)$$

and $\frac{d^2 C_j^i(Q_j^i)}{d^2 Q_j^i} < 0$. The use of this function allows for a clearer comparison of the results as the marginal cost function includes both a constant factor denoted by c_j and a varying factor $d_j Q_j^i$. To allow the examination of decreasing marginal cost, parameter $d_j < 0$ captures the decreasing effect of the marginal cost and can be considered as the rate at which the cost schedule declines. Note that $d_j \geq 0$, refer to increasing and constant marginal costs respectively, thus equation 2.6 provides a more general expression of marginal costs.

The policy measures provided by the respective active governments are set per unit:

$$S_j^i = s_j^i Q_j^i \quad (2.7)$$

As in the original Brander and Spencer model, a utility function $U(.)$ is adopted, such that consumers' surplus from the consumption of total output Q^i is given by the form:

$$CS^i = U(Q^i) - PQ^i \quad (2.8)$$

The consumption of the total production is shared among the consumers in the three countries served by the two producing firms, therefore the total consumers' surplus to be captured is divided between these countries, as the consumers of each country will be capturing a fraction of the total CS^i . For the two producing countries, the CS^i share parameters are denoted by ζ for country 1 and γ for country 2. Note that $\gamma + \zeta \leq 1$, implying that the third country's consumers will be capturing the remaining fraction of the surplus. Hence,

$$CS_j^i = \lambda CS^i \quad (2.9)$$

where $\lambda = \zeta, \gamma$ accordingly.

$$CS_1^i = \zeta CS^i \text{ and } CS_2^i = \gamma CS^i \quad (2.10)$$

With regards to the actual form of the utility function, we assume that all consumers are identical and therefore face the same utility. As Brander and Spencer [8], whose analysis is followed in this chapter, suggest, the form of this function should be such that the following condition is satisfied:

$$\frac{dU(Q^i)}{dQ^i} = P \quad (2.11)$$

Therefore the utility function takes the form:

$$U(Q^i) = \int_0^{Q^i} P = aQ^i - \frac{b}{2}(Q^i)^2 \quad (2.12)$$

\Rightarrow

$$CS^i = \frac{b}{2}(Q^i)^2 \quad (2.13)$$

2.3.2 Overview

Brander and Spencer with Cost Asymmetry

In the original two stage non-cooperational model described by Brander and Spencer [8], the first stage involves the setting of the policy measure by each respective government, aiming at placing its national firm at a Stackelberg leader position and the second, the setting of the optimal production level by each firm.

Using backward induction, the analysis begins with the setting of the optimal production level, where each of the two producing firms sets its output through the maximisation

of a profit function, incorporating the policy measure provided by its own protectionistic government. Thus the profit function for firm is given by:

$$\Pi_j^{NC} = P(Q^{NC})Q_j^{NC} - C_j(Q_j^{NC}) + s_j^{NC}Q_j^{NC} \quad (2.14)$$

The first order condition of the objective function leads to the setting of the optimal output level, as a function of the policy measure provided by the government and the cost level, $Q_j^{NC} = Q(s_1^{NC}, s_2^{NC}, C_j)$.

In the first stage of the game, the policy maker of country j sets the optimal policy measure s_j^{NC} that maximises her objective function comprising of the consumers' surplus, the profits realised by her national firm competing in country 3 and the subsidy bill:

$$W_j^{NC} = CS_j^{NC} + \Pi_j^{NC} - s_j^{NC}Q_j^{NC} \quad (2.15)$$

Joint Welfare Maximisation (*Type I*)

This co-operation agreement type, describes the situation, in which the policy makers, aiming at optimising their combined welfare, set their policy measures, through the maximisation of a joint welfare function. Firms then set their output levels, given the policy measures set. This particular cooperation scheme was briefly analysed by Brander and Spencer under a cost symmetry regime. The two stages involve the setting of the optimal policy measures in stage 1, and the setting of the optimal production levels in stage 2. Once again, employing backward induction, this co-operational agreement can be described by the following; in stage 2 each firm maximises its profit function:

$$\Pi_j^J = P(Q^J)Q_j^J - C_j(Q_j^J) + s_j^JQ_j^J \quad (2.16)$$

The output levels set by the two firms will be a function of their respective cost levels and the policy measures set by the two governments: $Q_j^J = Q(s_1^J, s_2^J, C_j)$.

In the first stage, the two policy makers set the optimal policy measure s_j^J that maximises their joint objective function comprising of the consumers' surplus, the profits realised by each country's national firm competing in country 3 and the subsidy bill:

$$W^J = W_1^J + W_2^J = CS_1^J + \Pi_1^J - s_1^J Q_1^J + CS_2^J + \Pi_2^J - s_2^J Q_2^J \quad (2.17)$$

Co-production Agreement (*Type 2*)

This agreement type consists of three stages; in stage one, the two policy makers set their optimal non cooperative policy measures through the maximisation, each of their own respective welfare function. The second is the bargaining stage between the two rival firms, in which they make a decision on whether to co-operate or not. The last stage involves the setting of the optimal joint production output. In this cost asymmetric setting, when the firms choose to co-produce, the lowest cost firm will be the one to undertake all production, as this will ensure cost minimisation and thus allow for higher profits to be extracted.

The use of backward induction, allows us to describe this agreement type, where in stage three the two firms, cooperate in the output setting and the lowest cost firm, undertakes all production. The output level $Q^c = Q(s_1^c, s_2^c, C_2)$ is set through the maximisation of the following profit function in stage 3:

$$\Pi^c = P(Q^c)Q^c - C_j(Q^c) + s_1^c Q^c + s_2^c Q^c \quad (2.18)$$

The two policy measures included in function account for the fact that both the two co-producing firms will present total output as their own and thus claim the protectionist

measure provided by their respective government. Also note that in this framework, the subscript j denotes the cost efficient firm. For the constant marginal cost case, this will be firm 2. In the second stage of the game, firms bargain over the potential additional profits (gain G) derived by their participation in a cooperational agreement, compared to the status quo of no cooperation, given by:

$$G_1^c = \delta(\Pi^c - \Pi^{NC}) \text{ and } G_2^c = (1 - \delta)(\Pi^c - \Pi^{NC}) \quad (2.19)$$

Parameter δ denotes the profit share parameter, the rate at which the additional gain will be divided between the two firms. This parameter takes values from the interval $[0, 1]$

$$L = (G_1^c)^\beta (G_2^c)^{(1-\beta)} \quad (2.20)$$

The maximisation of the Nash product, given by Equation 2.20, provides the optimal profit share parameter δ . Parameter β ($\beta \in [0, 1]$) in the equation, is the bargaining power parameter of the low cost firm assumed to be higher in value, the greater the cost asymmetry level.

Lastly in stage one, each of the two policy makers maximises their welfare function and sets their policy measure s_j^c :

$$W_j^c = CS_j^c + \Pi_j^c - s_j^c Q_j^c \quad (2.21)$$

Joint Welfare Maximisation and Co-production Agreement (Type 3)

The third type of cooperational agreement also involves a three stage game; stages 2 and 3 are similar to the ones described in the previous section describing the co-production agreement and illustrated by equations 2.18-2.21. The difference with the co-production

agreement lies in the first stage, where in agreement type 3, the two policy makers also co-operate in the setting of policy measures that maximise their joint welfare function. Using backward induction and general function forms, stage 3 involves the setting of the optimal output level through the maximisation of the joint profit function, where the production is undertaken by the lowest cost firm.

$$\Pi^{Jc} = P(Q^{Jc})Q^{Jc} - C_j(Q^{Jc}) + s_1^{Jc}Q^{Jc} + s_2^{Jc}Q^{Jc} \quad (2.22)$$

The second stage involves the derivation of the profit share parameter δ , which allows firms to agree on co-production. The gain from such an agreement for each firm is given by:

$$G_1^{Jc} = \delta(\Pi^{Jc} - \Pi^c) \text{ and } G_2^{Jc} = (1 - \delta)(\Pi^{Jc} - \Pi^c) \quad (2.23)$$

This parameter is obtained through the maximisation of the Nash Product:

$$L = (G_1^{Jc})^\beta (G_2^{Jc})^{(1-\beta)} \quad (2.24)$$

Lastly in stage one, the two policy makers set their optimal co-operational policy measures s_1^{Jc} and s_2^{Jc} through the maximisation of their joint welfare function:

$$W^{Jc} = CS_1^{Jc} + CS_2^{Jc} + \Pi^{Jc} - s_1^{Jc}Q^{Jc} - s_2^{Jc}Q^{Jc} \quad (2.25)$$

This section of the paper, has provided a brief overview of the non cooperational and co-operational agreement types to be examined in this analysis. The following section provides further insight, through a more detailed examination, employing linear functions for illustration and simplification purposes.

2.3.3 Linear Approximation Analysis Constant Marginal Costs

Brander and Spencer with Cost Asymmetry-no cooperation

The analysis begins with the examination of the Brander and Spencer model with cost asymmetry, with no cooperation between any of the agents involved. In summary, this involves a two stage game which comprises of the policy stage and the production stage. In more detail, the policy stage (stage 1) sees the two policy makers, the two governments set their optimal protectionist measures, aiming in this way to maximise their objective welfare functions. In the second stage (production stage) the two monopolies set their optimal output levels through the maximisation of their own objective functions, their profit functions, keeping into consideration the policy measures set in stage 1.

In more detail, in the non cooperation case, both governments provide protection for their domestic firms, however, firms do not explicitly take into consideration consumers' welfare in their objective functions; rather, the output decision is only indirectly influenced by this, through the optimal protectionist levels, set to maximise total welfare for the government, which includes both the profits of firms and welfare of consumers.

Stage 2

Using backward induction, the second stage involves the maximisation of the respective profit functions of the two producing firms, as can be observed below:

$$\Pi_1^{NC} = P(Q)Q_1^{NC} - c_1Q_1^{NC} + s_1^{NC}Q_1^{NC} \quad (2.26)$$

$$\Pi_2^{NC} = P(Q)Q_2^{NC} - c_2Q_2^{NC} + s_2^{NC}Q_2^{NC} \quad (2.27)$$

Maximising the functions and solving the first order conditions ($\frac{d\Pi_1^{nc}}{ds_1^{NC}} = 0$ and $\frac{d\Pi_2^{nc}}{ds_2^{NC}} = 0$) leads to the derivation of the following output level expressions as functions of the subsidy levels set in stage 1.

$$Q_1^{NC} = \frac{a + c_2 + 2s_1^{NC} - s_2^{NC} - 2c_1}{3b} \quad (2.28)$$

and

$$Q_2^{NC} = \frac{a + c_1 + 2s_2^{NC} - s_1^{NC} - 2c_2}{3b} \quad (2.29)$$

Thus in general forms, the total output level and the price level, as functions of the protectionist measures are equal:

$$Q^{NC} = \frac{2a - c_1 - c_2 + s_1^{NC} + s_2^{NC}}{3b} \quad (2.30)$$

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and

$$P^{NC} = \frac{a + c_1 + c_2 - s_1^{NC} - s_2^{NC}}{3} \quad (2.31)$$

Therefore, the profit levels are given by:

$$\Pi_1^{NC} = \frac{(a + 2s_1^{NC} + c_2 - 2c_1 - s_2^{NC})^2}{3b} \quad (2.32)$$

and

$$\Pi_2^{NC} = \frac{(a + 2s_2^{NC} + c_1 - 2c_2 - s_1^{NC})^2}{3b} \quad (2.33)$$

¹⁰ The non negativity constraints, ensuring that the output will be positive are given by the following conditions:

$$2s_1 - s_2 > -(a - 2c_1 + c_2)$$

and

$$2s_2 - s_1 > -(a - 2c_2 + c_1)$$

for Q_2 and Q_1

Note that the profit functions are independent of the consumption parameters analysed earlier, proving the point that the output decision of firms does not depend on consumers' welfare choices by the producers.

Stage 1

Next, we move to the first stage of the game, in which the governments set their optimal policy measures, through the maximisation of their objective functions. These functions include both the respective domestic profits, but also the domestic consumers' surplus. The function equals:

$$W_j^{NC} = \lambda[U(Q^{NC}) - PQ^{NC}] + \Pi_j^{NC} - s_j^{NC}Q_j^{NC} \quad (2.34)$$

for $j = [1, 2]$ and $\lambda = [\zeta, \gamma]$ accordingly.

Maximising with respect to the policy measures, the FOCs derived for countries 1 and 2 respectively:

$$\frac{dW_1^{NC}}{ds_1^{NC}} = \zeta \left[\frac{dU_1^{NC}}{ds_1^{NC}} - \frac{dP^{NC}}{ds_1^{NC}} Q^{NC} - \frac{dQ^{NC}}{ds_1^{NC}} P^{NC} \right] + \frac{d\Pi_1^{NC}}{ds_1^{NC}} - Q_1^{NC} - \frac{dQ_1^{NC}}{ds_1^{NC}} s_1^{NC} = 0 \quad (2.35)$$

\Rightarrow

$$\frac{dW_1^{NC}}{ds_1^{NC}} = -\frac{dP^{NC}}{ds_1^{NC}} \zeta Q^{NC} + \frac{d\Pi_1^{NC}}{ds_1^{NC}} - Q_1^{NC} - \frac{dQ_1^{NC}}{ds_1^{NC}} s_1^{NC} = 0 \quad (2.36)$$

and

$$\frac{dW_2^{NC}}{ds_2^{NC}} = -\frac{dP^{NC}}{ds_2^{NC}} \gamma Q^{NC} + \frac{d\Pi_2^{NC}}{ds_2^{NC}} - Q_2^{NC} - \frac{dQ_2^{NC}}{ds_2^{NC}} s_2^{NC} = 0 \quad (2.37)$$

The specific functions used, when differentiated with respect to the policy measure, define the following optimal levels for the non- co-operational case.

$$s_1^{NC} = \frac{(3\zeta - \gamma + 1)a - (\zeta - \gamma + 3)c_1 + 2(1 - \zeta)c_2}{(5 - \gamma - \zeta)} \quad (2.38)$$

and

$$s_2^{NC} = \frac{(3\gamma - \zeta + 1)a - (\gamma - \zeta + 3)c_2 + 2(1 - \gamma)c_1}{(5 - \gamma - \zeta)} \quad (2.39)$$

Using these values and substituting in the output and profit functions in each country, the following results are obtained. Note that the output and in extension profits depend on whether the non negativity constraint holds, which in turn depends on the consumers' surplus share parameters. Denoting by: $\kappa = (\zeta - \gamma + 1)$, $\eta = (3 - \gamma)$, $\nu = (2 - \zeta)$, $\theta = (5 - \gamma - \zeta)$, $\mu = (\gamma - \zeta + 1)$, $\sigma = (2 - \gamma)$, $\psi = (3 - \zeta)$, $\phi = (4 - \gamma)$, $\chi = (3 - \zeta - \gamma)$, $\xi = (1 - \zeta)$.

$$Q_1^{NC} = \begin{cases} \frac{2[a\kappa - \eta c_1 + \nu c_2]}{\theta b} & \text{if } ka - \eta c_1 + \nu c_2 > 0 \\ 0 & \text{(otherwise)} \end{cases} \quad (2.40)$$

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and

$$Q_2^{NC} = \begin{cases} \frac{2[a\mu - \psi c_2 + \sigma c_1]}{\theta b} & \text{if } ka - \eta c_1 + \nu c_2 > 0 \\ \frac{(a - c_2)}{(2 - \gamma - \zeta)b} & \text{otherwise} \end{cases} \quad (2.41)$$

$$Q^{NC} = \begin{cases} \frac{2(2a - c_1 - c_2)}{\theta b} & \text{if } ka - \eta c_1 + \nu c_2 > 0 \\ \frac{(a - c_2)}{(2 - \gamma - \zeta)b} & \text{otherwise} \end{cases} \quad (2.42)$$

The profit levels corresponding to the above output levels:

$$\Pi_1^{NC} = \begin{cases} \frac{4[a\kappa - \eta c_1 + \nu c_2]^2}{\theta^2 b} & \text{if } ka - \eta c_1 + \nu c_2 > 0 \\ 0 & \text{otherwise} \end{cases} \quad (2.43)$$

and

$$\Pi_2^{NC} = \begin{cases} \frac{4[a\mu - \psi c_2 + \sigma c_1]^2}{\theta^2 b} & \text{if } ka - \eta c_1 + \nu c_2 > 0 \\ \frac{(a - c_2)^2}{(2 - \gamma - \zeta)^2 b} & \text{(otherwise)} \end{cases} \quad (2.44)$$

¹¹ Note that the non negativity constraints take to form: $(\kappa a - \eta c_1 + \nu c_2) > 0$ and $(\mu a - \psi c_2 + \sigma c_1) > 0$ for $Q_1^{NC} > 0$ and $Q_2^{NC} > 0$ respectively. The second constraint holds for all values of the consumers' surplus share parameters, whereas the former may or may not hold. This would imply that firm 2, the low cost firm, will always produce either at the monopoly or the duopoly levels, whereas firm 1 will either produce zero quantities or at the duopoly respectively, depending on the constraint.

Essentially, the main result arising from the above function is the fact that the high cost firm produces at a positive duopoly level if the constraint holds, thus derives positive profits; in the case however, that the constraint does not hold, then its production level is zero and in extension, so is its profit level.

Therefore, the above functions lead to the following conclusion in terms of the total profit and welfare levels:

$$\Pi^{NC} = \begin{cases} \frac{4[(a\kappa - \eta c_1 + \nu c_2)^2 + (a\mu - \psi c_2 + \sigma c_1)^2]}{\theta^2 b} & \text{if } ka - \eta c_1 + \nu c_2 > 0 \\ \frac{(a - c_2)^2}{(2 - \gamma - \zeta)^2 b} & \text{(otherwise)} \end{cases} \quad (2.45)$$

and

$$W^{NC} = \begin{cases} \frac{4[c_1^2 \phi + c_2^2 (\psi^2 - \gamma \nu) + a^2 (\phi \gamma + \zeta^2) - c_1 c_2 \phi \chi]}{\theta^2 b} + \frac{a(c_1 \phi (\xi - \gamma) - c_2 (6 + 3\gamma - \gamma^2 - (8 - \gamma)\zeta + 2\zeta^2))}{\theta^2 b} & \text{if } ka - \eta c_1 + \nu c_2 > 0 \\ \frac{(a - c_2)^2}{(2 - \gamma - \zeta)^2 b} - \frac{(\gamma + \zeta)((a - c_2)^2)}{2(2 - \gamma - \zeta)^2 b} & \text{(otherwise)} \end{cases} \quad (2.46)$$

The above expressions imply, that if the non negativity condition holds, then a Cournot Duopoly operates in the market; in contrast to the case, where the consumption levels which define the constraints, lead to the operation of a monopoly in the form of the lowest cost firm.

Potential Gains from Cooperation

The non cooperative case of strategic trade policy as described in the a la Brander and Spencer framework, albeit with asymmetric costs (as per Neary [61]), leads to the setting of a two firm Cournot output, with the lowest cost firm capturing the highest production and profit levels. Particularly for the case where the non negativity constraints do not hold, the lowest cost firm is the sole producer serving all the markets, capturing total profits. When this occurs, we are able to observe that under certain conditions, regarding the consumption

level, the monopoly profits are greater or at least equal to the non cooperation case. Thus, there would be a rationale for the firms to try to capture this effect through the formation of a co-operational agreement, establishing the lowest cost firm as the chosen monopolist.

Co-production agreements, as one form of potential cooperation between firms, have been analysed in the literature in the past, with a focus on the potential gains from such endeavours, mainly stemming from cost synergies. These take the form of economies of scale and production rationalization; the former are based on the trait that the larger output production to be undertaken by the one firm will lead to a lower average cost plus the additional benefit that the cost advantage of the low cost firm can be fully exploited, as described in Contractor and Lorange [21], [22]. The latter is described as production rationalisation, since production is transferred to the firm operating with lower costs and thus this firm's location has a comparative advantage, leading to lower overall costs.

Therefore, the model described in this thesis, focuses mainly on the production rationalisation and cost synergies realised, through the transfer of output setting to the lowest cost firm, when the two rival firms choose to cooperate. The existence of strategic measures, provided by the policy makers, could also create incentives for these to cooperate in the claim for policy measures from their respective countries. This could be done in an effort to set higher claims and thus benefit from higher positive policy measures, that would increase profits for the firms. Such incentives will, as analysed in the following sections, prove to be over-optimistic and inaccurate, as the government will be in the position to capture these moves and set the policy measures accordingly.

The governments, as described in Brander and Spencer [8] may have the incentive to cooperate in the setting of the policy measures, as these would be set at lower levels, particularly in the case of subsidisation and thus increase the combined welfare levels. Gains resulting from the cooperation of governments, therefore stem from the reduction in the policy measures, leading to both the reduction of the policy bills and a correction in the setting of the output, directly influenced by the protectionist measures, as the joint setting of measures reduces protectionism.

Co-operational agreements

As the benchmark case of no cooperation has now been set, the analysis is turned to the examination of all the potential co-operational schemes, as previously described. Hence, the potential cooperational agreements to be analysed include namely **joint welfare maximisation**, in which the governments only choose to cooperate, through the maximisation of a joint welfare function for the setting of the optimal policy measures, **coproduction**, in which the duopoly that serves the third market becomes a monopoly when the two firms enter an agreement for production to be undertaken by only the cost efficient of the two firms and lastly the combination of the two above cooperational methods, **joint welfare maximisation combined with coproduction**, in which both the governments and the firms maximise joint welfare functions.

Joint Welfare maximisation (Type 1)

This particular cooperational scheme was originally analysed by Brander and Spencer [8], when consumption in the two producing countries was allowed, under the cost symme-

try assumption. Thus some parts of the analysis follow the particular model quite closely. This potential co-operation type involves a government level cooperation, in which the governments maximise a joint welfare function, in the aim of increasing their welfare through cooperation.

As described in section 2.3.2, backward induction is used to establish the optimal policy measures provided and in extension the profit and welfare levels.

Stage 2

In this stage, firms set their optimal production levels, based on the policy measures set in stage 1. The profits functions are not directly influenced by consumers's welfare and thus the results are the same as in stage 2 of the non cooperation case in their general form (Equations 2.32 & 2.33).

$$\Pi_1^J = \frac{(a + 2s_1^J + c_2 - 2c_1 - s_2^J)^2}{3b} \quad (2.47)$$

and

$$\Pi_2^J = \frac{(a + 2s_2^J + c_1 - 2c_2 - s_1^J)^2}{3b} \quad (2.48)$$

Stage 1

At this stage, the two policy makers maximise a joint welfare function in order to set the optimal policy measure. Therefore, the main function to be used here is the joint function derived through the summation of the two separate welfare functions:

$$W^J = W_1^J + W_2^J = \zeta[U(Q^J) - PQ^J] + \Pi_1^J - s_1^J Q_1^J + \gamma[U(Q^J) - PQ^J] + \Pi_2^J - s_2^J Q_2^J \quad (2.49)$$

Proposition 6 *The co-operation on a policy maker level leads to the setting of a tax for the high cost firm and a positive subsidy for the low cost firm, resulting in the high cost*

firm driven off the market and thus allowing the low cost firm to produce at a monopolistic level. Therefore the joint welfare maximisation agreement at the government level, leads to the endogenous formation of a monopoly. The two measures set are given by:

$$s_1^J = \frac{(1 - \gamma - \zeta)a + c_2 + (\gamma + \zeta - 2)c_1}{\gamma + \zeta - 2} < 0 \quad (2.50)$$

and

$$s_2^J = \frac{-(\gamma + \zeta)a + (\gamma + \zeta)c_2}{\gamma + \zeta - 2} > 0 \quad (2.51)$$

The corresponding profit and welfare levels equal:

$$\Pi_1^J = 0 \quad (2.52)$$

and

$$\Pi_2^J = \frac{(a - c_2)^2}{(2 - \gamma - \zeta)^2 b} \quad (2.53)$$

$$W_1^J = \zeta \frac{(a - c_2)^2}{2(2 - \gamma - \zeta)^2 b} \quad (2.54)$$

and

$$W_2^J = \gamma \frac{(a - c_2)^2}{2(2 - \gamma - \zeta)^2 b} + \frac{(a - c_2)^2}{(2 - \gamma - \zeta)^2 b} - \frac{(\gamma + \zeta)((a - c_2)^2)}{(2 - \gamma - \zeta)^2 b} \quad (2.55)$$

Proof. In Appendix B.1 ■

Proposition 7 The total profit and welfare levels for the joint welfare maximisation case are therefore given by:

$$\Pi^J = \Pi_1^J + \Pi_2^J = 0 + \frac{(a - c_2)^2}{(2 - \gamma - \zeta)^2 b} \quad (2.56)$$

and

$$W^J = W_1^J + W_2^J = \frac{(a - c_2)^2}{(2 - \gamma - \zeta)^2 b} - \frac{(\gamma + \zeta)((a - c_2)^2)}{2(2 - \gamma - \zeta)^2 b} \quad (2.57)$$

Proof. In Appendix B.1 ■

Note that Brander and Spencer, in their cost symmetry setting, discuss the cooperation of the two governments in order to set total output at a two-firm monopoly level. Here the asymmetry leads to the setting of monopoly output, produced only by the lowest cost firm. Therefore the main conclusion is the fact that when the governments aim to maximise their joint welfare, their policy measures are set in such a way that endogenously a monopolistic outcome is derived. Therefore this cooperational agreement leads to the endogenous formation of a monopoly, whereby only the lowest cost firm will produce, as a result of the policy measures set, compared to the exogenous formation of monopolies in type 2 and type 3 co-operational agreements, where the firms consent to the lowest cost firm undertaking all production, in order to gain from potential cost synergies.

Co-production Agreement (Type 2)

The game for this agreement type consists of the following three stages; in stage one, the governments set the optimal policy measure, through the maximisation of their individual welfare functions, thus the policy measures set are non-cooperatively. This type of agreement is based on the idea that firms in each of the two markets offering protectionist measures may try to exploit this fact, by jointly producing and claiming the measures. The potential gain from such a move is the decrease in the output level, to the monopoly one, therefore the increase in the price received. Hence, stage two involves the bargaining over the profits from this type of agreement and stage three involves the setting of the optimal output level.

As the firms by assumption differ in their cost levels, the lowest cost firm will be undertaking the production of the total output, on behalf of both the producing agents. This move allows the two firms to exploit potential cost synergies, in comparison to the case where both the producing firms chose to produce as a 'two firm monopoly'. Using backward induction, we obtain the following:

Stage 3

The two firms define their optimal production level through the maximisation of their profit function. Here, as a result of the claim of protectionist measures from both policy makers, the profit function takes the following form:

$$\Pi^c = \Pi(Q^c, c_2, s_1^c, s_2^c) = P(Q^c)Q^c - c_2Q^c + s_1^cQ^c + s_2^cQ^c \quad (2.58)$$

Essentially, firms try to 'cheat' their respective governments by claiming ownership of their entire output level. Here s_1^c and s_2^c denote the policy measures to be provided by each of the two governments.

Differentiating with respect to the production level the following output level is obtained as a function of the two policy measures.

$$Q^c = \frac{a - c_2 + s_1^c + s_2^c}{2b} \quad (2.59)$$

The price level is given by

$$P(Q^c) = \frac{a + c_2 - s_1^c - s_2^c}{2} \quad (2.60)$$

Note that The output non negativity constraint must hold for a positive output level to be produced. Hence,

$$\Pi^c = \begin{cases} \frac{(a-c_2+s_1^c+s_2^c)^2}{4b} & \text{if } s_1^c + s_2^c > c_2 - a \\ 0 & \text{otherwise} \end{cases} \quad (2.61)$$

Stage 2

In stage 2, firms may try to embark on a co-production agreement that could allow both of them to have access to the protectionist measures provided by both countries and in this way try to exploit their roles as national champions. In such a situation, the two firms will firstly bargain over the potential additional profits from this move. Their outside options are defined by the level of profits in the no cooperation case, as governments are not participating in a co-operational agreement and thus if firms choose not to cooperate, a Brander and Spencer type game is followed. Essentially, this examination aims to establish whether there is a potential path of ensuring that the WTO efforts of reducing subsidisation levels can be accomplished through endogenous agreement formations between firms.

The profits for each firm if they engage in this type of agreement are defined by their outside option, plus the share of the profit increase through co-operation:

$$\Pi_1^c = \Pi_1^{NC} + \delta(\Pi^c - \Pi_1^{NC} - \Pi_2^{NC}) \quad (2.62)$$

and

$$\Pi_2^c = \Pi_2^{NC} + (1 - \delta)(\Pi^c - \Pi_1^{NC} - \Pi_2^{NC}) \quad (2.63)$$

where $\delta \in [0, 1]$ denotes the profit share parameter, which enables the firms to optimally divide the additional profits.

The gain from this type of co-operational agreement for the two firms is defined by the difference between the profits in the co-production agreement case, minus the profit of in the case of no cooperation (status quo):

$$\begin{aligned} G_1^c &= \Pi_1^c - \Pi_1^{NC} \\ &= \delta(\Pi^c - \Pi_1^{NC} - \Pi_2^{NC}) \end{aligned} \quad (2.64)$$

and

$$\begin{aligned} G_2^c &= \Pi_2^c - \Pi_2^{NC} \\ &= (1 - \delta)(\Pi^c - \Pi_1^{NC} - \Pi_2^{NC}) \end{aligned} \quad (2.65)$$

The bargaining stage begins as firms realise their particular bargaining power level. Nature has assigned each firm with a specific ability parameter. In the set-up examined here, this takes the form of the firm's marginal production cost. As the firms compete in quantities and the production cost is an important element of the production function, the power of each firm in the international market is here assumed to be given by the production cost parameter (ability). Hence, the lowest cost/ high efficiency firm will portray higher bargaining power, as through its cost advantage attains a greater profit level.

There are two ways of interpreting the above claim, of the difference in the bargaining levels of the firm; one would be that, in the original Brander and Spencer model, symmetry was assumed for the two rival nations, and as a result, in equilibrium the two countries share the profits from the third no producing country (any rent shifting for one country will be counter-balanced by that of its rival). In an asymmetric situation, analysed by Neary [61], however, the lowest cost firm will be receiving a higher subsidy (as in de Meza [24])

and will shift more rents, when this is characterised by a lower cost level compared to the foreign rival. The incentive of the cost disadvantaged nation to provide a protectionist measure is reduced and the firm may seek a different way for increasing its profits. If the high cost firm was able to use the production cost of its rival firm, then it would observe an increase in its profits. Coproduction to a single firm monopoly level, lower than the Cournot duopoly creates the potential for higher profits; the firms would be able to share this increase in such a way, so as to make this co-operational agreement advantageous.

Therefore, depending on the cost level, each firm is characterised by a bargaining power parameter, so that the low cost firm receives a higher proportion of the increased profits; an incentive to accept this form of co-operational agreement. For the principles of bargaining theory, as the outside option entails the asymmetry and the low cost firm receives the higher share of the profits, setting the profit share parameter to $\frac{1}{2}$ would be sufficient. Then the second stage would not be necessary and the same results would be obtained, without loss of generality. For this analysis, however, we shall continue with the use of the general term δ , for a more generalised result.

A second interpretation for the existence of a difference in the bargaining parameters stems from the notion introduced in Chen and Ross [13], where, if permitted, an incumbent would bribe any entrant in order to drive her off the market. Hence the entrant would not produce any positive level of output, but would still receive a share of the profits, to ensure that the monopolist will not face the possibility of not being the sole provider in the market. This would allow the most cost efficient firm to be the monopolist. In terms of the set-up of the model described in our paper, the lowest cost firm wishes to produce at the single

firm monopoly level, so it provides the high cost firm with a specific profit share, higher than what it would receive in the absence of this cooperation, and in a sense drives it off the market. The main difference of the model described here and Chen and Ross [13], lies in the aspect of protectionism; Even though the output is produced by one firm only, the agreement allows for a particular share to be owned by each firm, so subsidisation can be claimed in both countries.

Hence, a bargaining parameter β is introduced, with $\beta_1 < \beta_2 \Leftrightarrow c_1 > c_2$, implying that the lower the production cost of the participant, the higher her bargaining power, $\beta \in [0, 1]$ and $\beta_1 + \beta_2 = 1$. These parameters can also be defined as $\beta_1 = \beta$ and $\beta_2 = 1 - \beta$.

The Nash product for this particular situation is given by:

$$L = (G_1^c)^\beta (G_2^c)^{1-\beta} \quad (2.66)$$

In more detail:

$$\begin{aligned} L &= [\delta(\Pi^c - \Pi_1^{NC} - \Pi_2^{NC})]^\beta [(1 - \delta)(\Pi^c - \Pi_1^{NC} - \Pi_2^{NC})]^{1-\beta} \\ &= (\Pi^c - \Pi_1^{NC} - \Pi_2^{NC}) \delta^\beta (1 - \delta)^{1-\beta} \end{aligned} \quad (2.67)$$

The first order condition with respect to the profit share parameter equals:

$$\frac{dL}{d\delta} = (\Pi^c - \Pi_1^{NC} - \Pi_2^{NC}) [\beta \delta^{\beta-1} (1 - \delta)^{1-\beta} + (\Pi^c - \Pi_1^{NC} - \Pi_2^{NC}) (1 - \beta) \delta^\beta (1 - \delta)^{-\beta}] = 0 \quad (2.68)$$

Simplifying and rearranging we obtain:

$$\beta(1 - \delta) = (1 - \beta)\delta \implies \delta = \beta \quad (2.69)$$

The result of the bargaining power analysis is that the profit share parameter equals the bargaining power parameter. Hence, the country with the higher bargaining power will be the recipient of the higher share of the profit. Essentially this is a result to be expected, since the low cost player requires the highest proportion of the 'profit margin' as compensation for not continuing the rivalry in the production stage. Thus the profits for each firm can be re-written:

$$\Pi_1^c = \Pi_1^{NC} + \beta(\Pi^c - \Pi_1^{NC} - \Pi_2^{NC}) \quad (2.70)$$

and

$$\Pi_2^c = \Pi_2^{NC} + (1 - \beta)(\Pi^c - \Pi_1^{NC} - \Pi_2^{NC}) \quad (2.71)$$

Stage 1

In this stage the optimal protectionist measures are defined by the policy makers, through the maximisation of their individual welfare functions. Inward consumption implies that these will include consumers' surplus. Note that here, as both firms claim ownership of the output, both governments will face a policy measure provision.

The welfare functions are given respectively by:

$$W_1^c = CS_1^c + \Pi_1^c - s_1^c Q^c = \zeta[U(Q^c) - PQ^c] + \Pi_1^{NC} + \beta(\Pi^c - \Pi_1^{NC} - \Pi_2^{NC}) - s_1^c Q^c \quad (2.72)$$

and

$$W_2^c = CS_2^c + \Pi_2^c - s_2^c Q^c = \gamma[U(Q^c) - PQ^c] + \Pi_2^{NC} + (1 - \beta)(\Pi^c - \Pi_1^{NC} - \Pi_2^{NC}) - s_2^c Q^c \quad (2.73)$$

The first order conditions are given by:

$$\frac{dW_1^c}{ds_1^c} = -\zeta \frac{dP^c}{ds_1^c} Q^c + \beta \frac{d\Pi^c}{ds_1^c} - Q^c - \frac{dQ^c}{ds_1^c} s_1^c = 0 \quad (2.74)$$

and

$$\frac{dW_2^c}{ds_2^c} = -\gamma \frac{dP^c}{ds_2^c} Q^c + \beta \frac{d\Pi^c}{ds_2^c} - Q^c - \frac{dQ^c}{ds_2^c} s_2^c = 0 \quad (2.75)$$

Solving the system of equations establishes the following protectionist measures;

$$s_1^c = \frac{(\zeta + 2\beta - 2)(a - c_2)}{(4 - \zeta - \gamma)} \quad (2.76)$$

and

$$s_2^c = \frac{(\gamma - 2\beta)(a - c_2)}{(4 - \zeta - \gamma)} \quad (2.77)$$

Note that

$$\begin{aligned} & \Pi_1^c + \Pi_2^c \\ &= \Pi_1^{NC} + \beta(\Pi^c - \Pi_1^{NC} - \Pi_2^{NC}) + \Pi_2^{NC} + (1 - \beta)(\Pi^c - \Pi_1^{NC} - \Pi_2^{NC}) \\ &= \Pi^c \end{aligned} \quad (2.78)$$

The protectionist measures, when substituted in the production and inverse demand functions, give the following output and price levels.

$$Q^c = \frac{(a - c_2)}{(4 - \gamma - \zeta)b} \quad (2.79)$$

¹² and

$$P^c = \frac{(3 - \gamma - \zeta)a + c_2}{(4 - \gamma - \zeta)b} \quad (2.80)$$

¹² Note that as $\gamma + \zeta \leq 1 \Rightarrow \gamma + \zeta < 4 \Rightarrow 4 - \gamma - \zeta > 0 \Rightarrow Q^c > 0$

The total profit and welfare functions are given respectively by:

$$\Pi^c = \frac{(a - c_2)^2}{(4 - \gamma - \zeta)^2 b} \quad (2.81)$$

and

$$W^c = \frac{(a - c_2)^2}{(4 - \gamma - \zeta)^2 b} - \frac{(\gamma + \zeta - 4)(a - c_2)^2}{(4 - \gamma - \zeta)^2 b} \quad (2.82)$$

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Co-production and Joint Welfare maximisation Agreement (Type 3)

The last type of co-operational activity to be examined here involves, as already mentioned, cooperation at both the principal and the agent level. Hence, governments maximise a joint welfare function to set the optimal protectionist measure, and the firms maximise their common profit function, setting in this way a monopoly output. The analysis is similar to the co-production (type 2) agreement, as it involves three stages, however, the difference here is that the policy makers jointly set the optimal protectionist measures.

Stage 3

In stage three the two firms maximise their common profit function:

$$\Pi^{Jc} = \Pi(Q^{Jc}, c_2, s_1^{Jc}, s_2^{Jc}) = P(Q^{Jc})Q^{Jc} - c_2Q^{Jc} + s_1^{Jc}Q^{Jc} + s_2^{Jc}Q^{Jc} \quad (2.83)$$

Deriving the first order conditions and solving the system leads to the derivation of the following equations for the output, price and profit level as functions of the policy measures:

$$Q^{Jc} = \frac{a - c_2 + s_1^{Jc} + s_2^{Jc}}{2b} \quad (2.84)$$

¹³ Note that $CS^c = \frac{(a-c_2)^2}{2(4-\gamma-\zeta)^2 b}$

$$P(Q^{Jc}) = \frac{a + c_2 - s_1^{Jc} - s_2^{Jc}}{2} \quad (2.85)$$

$$\Pi^{Jc} = \begin{cases} \frac{(a - c_2 + s_1^{Jc} + s_2^{Jc})^2}{4b} & \text{if } s_1^{Jc} + s_2^{Jc} > c_2 - a \\ 0 & \text{otherwise} \end{cases} \quad (2.86)$$

These functions have a similar form as the ones in the co-production agreement (type 2), as stages 2 and 3 involve the setting and maximisation of the same profit functions. For this type of agreement the only difference lies in stage 1, where the governments now do not maximise individual welfare functions for the setting of the optimal policy measures, but a joint function.

Stage 2

The bargaining stage, as in the previous section involves the potential profits from cooperation at both the firm and government level. The main difference with the previous case examined (Equations 2.64 and 2.65), is that the outside option for the firms is the profit when at least the two governments cooperate, therefore the profits derived from the joint welfare maximisation type of agreement. The gain functions are therefore given by:

$$G_1^{Jc} = \delta[\Pi^{Jc} - \Pi_1^J - \Pi_2^J] \quad (2.87)$$

and

$$G_2^{Jc} = (1 - \delta)[\Pi^{Jc} - \Pi_1^J - \Pi_2^J] \quad (2.88)$$

As described in Equation 2.69, this bargaining leads to the setting of the profit share parameter at the level of the bargaining power parameter:

$$\delta = \beta \quad (2.89)$$

Therefore the profits realised by each firm are given by:

$$\Pi_1^{Jc} = \Pi_1^J + \beta[\Pi^{Jc} - \Pi_1^J - \Pi_2^J] \quad (2.90)$$

and

$$\Pi_2^{Jc} = \Pi_2^J + (1 - \beta)[\Pi^{Jc} - \Pi_1^J - \Pi_2^J] \quad (2.91)$$

Stage 1

In stage one the two policy makers maximise their joint welfare function, to set the optimal protectionist measures which includes the consumers' surplus for each the two countries. As mentioned earlier this is a set proportion of the total consumers' surplus level $CS^{Jc} = [U(Q^{Jc}) - P^{Jc}Q^{Jc}]$.

$$\begin{aligned} W^{Jc} &= W_1^{Jc} + W_2^{Jc} \\ &= \zeta[U(Q^{Jc}) - P^{Jc}Q^{Jc}] + \Pi_1^{Jc} + \beta[\Pi^{Jc} - \Pi_1^J - \Pi_2^J] - s_1^{Jc}Q^{Jc} \\ &\quad + \gamma[U(Q^{Jc}) - P^{Jc}Q^{Jc}] + \Pi_2^{Jc} + (1 - \beta)[\Pi^{Jc} - \Pi_1^J - \Pi_2^J] - s_2^{Jc}Q^{Jc} \end{aligned} \quad (2.92)$$

The first order conditions are given by:

$$\begin{aligned} \frac{dW^{Jc}}{ds_1^{Jc}} &= -\zeta \frac{dP^{Jc}}{ds_1^{Jc}} Q^{Jc} + \beta \frac{d\Pi^{Jc}}{ds_1^{Jc}} - Q^{Jc} - \frac{dQ^{Jc}}{ds_1^{Jc}} s_1^{Jc} \\ &\quad - \gamma \frac{dP^{Jc}}{ds_1^{Jc}} Q^{Jc} + (1 - \beta) \frac{d\Pi^{Jc}}{ds_1^{Jc}} - \frac{dQ^{Jc}}{ds_1^{Jc}} s_1^{Jc} \\ &= 0 \end{aligned} \quad (2.93)$$

and for country 2:

$$\begin{aligned} \frac{dW^{Jc}}{ds_2^{Jc}} &= -\zeta \frac{dP^{Jc}}{ds_2^{Jc}} Q^{Jc} + \beta \frac{d\Pi^{Jc}}{ds_2^{Jc}} - Q^{Jc} - \frac{dQ^{Jc}}{ds_2^{Jc}} s_1^{Jc} \\ &\quad - \gamma \frac{dP^{Jc}}{ds_2^{Jc}} Q^{Jc} + (1 - \beta) \frac{d\Pi^{Jc}}{ds_2^{Jc}} - \frac{dQ^{Jc}}{ds_2^{Jc}} s_2^{Jc} \\ &= 0 \end{aligned} \quad (2.94)$$

Solving for the linear case, the following function is obtained as a sum of the two policy measures:

$$s_1^{Jc} + s_2^{Jc} = \frac{(\gamma + \zeta)(a - c_2)}{2 - \gamma - \zeta} \quad (2.95)$$

¹⁴The output defined by the above function is given by:

$$Q^{Jc} = \frac{(a - c_2)}{(2 - \gamma - \zeta)b} \quad (2.96)$$

The total profit and welfare functions are given by:

$$\Pi^{Jc} = \frac{(a - c_2)^2}{(2 - \gamma - \zeta)^2 b} \quad (2.97)$$

and

$$W^{Jc} = \frac{(a - c_2)^2}{(2 - \gamma - \zeta)^2 b} - \frac{(\gamma + \zeta)(a - c_2)^2}{2(2 - \gamma - \zeta)^2 b} \quad (2.98)$$

Co-operational Agreements Summary

This section examines the welfare and profit improvements provided by each of the three types of co-operational agreements, summarising the policy measures and profits and welfare levels, derived from the analysis in the previous subsections of 2.3.3 when these

¹⁴ The non negativity constraint becomes:

$$s_1^{Jc} + s_2^{Jc} = \frac{(\gamma + \zeta)(a - c_2)}{2 - \gamma - \zeta} > -(a - c_2) \implies$$

$$((\gamma + \zeta)(a - c_2) > -(a - c_2)(2 - \gamma - \zeta) \implies$$

$$2(a - c_2) > 0$$

positive by assumption, therefore a positive amount of output is produced.

are compared.

	J	c	Jc
Subsidy levels	$s_1^J = \frac{(1-\gamma-\zeta)a+c_2+(\gamma+\zeta-2)c_1}{\gamma+\zeta-2}$ $s_2^J = \frac{-(\gamma+\zeta)a+(\gamma+\zeta)c_2}{\gamma+\zeta-2}$	$s_1^c = \frac{(\zeta+2\beta-2)(a-c_2)}{(4-\zeta-\gamma)}$ $s_2^c = \frac{(\gamma-2\beta)(a-c_2)}{(4-\zeta-\gamma)}$	$s_1^{Jc} + s_2^{Jc} = \frac{(\gamma+\zeta)(a-c_2)}{2-\gamma-\zeta}$
Profits	$\Pi^J = \frac{(a-c_2)^2}{(2-\gamma-\zeta)^2b}$	$\Pi^c = \frac{(a-c_2)^2}{(4-\gamma-\zeta)^2b}$	$\Pi^{Jc} = \frac{(a-c_2)^2}{(2-\gamma-\zeta)^2b}$
Welfare	$W^J = \frac{(a-c_2)^2}{(2-\gamma-\zeta)^2b}$ $-\frac{(\gamma+\zeta)((a-c_2)^2)}{2(2-\gamma-\zeta)^2b}$	$W^c = \frac{(a-c_2)^2}{(4-\gamma-\zeta)^2b}$ $-\frac{(\gamma+\zeta-4)(a-c_2)^2}{(4-\gamma-\zeta)^2b}$	$W^{Jc} = \frac{(a-c_2)^2}{(2-\gamma-\zeta)^2b}$ $-\frac{(\gamma+\zeta)(a-c_2)^2}{2(2-\gamma-\zeta)^2b}$

Table 1: Subsidy, profit and Welfare Levels summary

One of the main observations from the above table is the fact that profits and welfare can be ranked in the following way:

$$\Pi^J = \Pi^{Jc} > \Pi^c \quad (2.99)$$

$$W^J = W^{Jc} > W^c \quad (2.100)$$

This implies that the two cooperational regimes involving government cooperation lead to the same level of profits and welfare. These levels are greater than the corresponding coproduction regime that does not involve government cooperation. Overall, all the regimes are ranked in the same way in terms of both profits and welfare, as we observe that Jc and J yield both higher profits and welfare than the c regime.

Government Effect on Cooperation

Observing Table 1, we can draw the following conclusions: the joint welfare maximisation J and the joint welfare maximisation with coproduction Jc cases lead to the same welfare and profit levels, whereas the coproduction case corresponds to lower levels. This

implies that when the government plays a supportive role in the agreement, there will be a positive welfare effect compared to the case where the government does not provide its consent. Thus, in order for profits and welfare to be high in a cooperational situation, the government's approval of the production setting is essential.

Therefore, when the government is in favour of co-operational agreements, and does not only look at its firm as the national champion, the lowest cost firm emerges as the monopolist in the market. Profits and welfare are lower than the one firm monopoly levels, when the governments do not take a favourable outlook towards cooperation, but rather have a stricter strategic trade approach, where the firm in each country is considered the national champion. As any deviation from this role leads to the setting of taxes, thus decreasing profits and in extension welfare.

Particularly for the two situations where the governments actively cooperate, type 1 and type 3 cooperational agreements, the lowest cost firm is left to capture total demand, as this decreases total costs. In the joint welfare maximisation, the low cost firm monopoly emerges endogenously, when the optimal policy measures maximising joint welfare are such that lead to zero production levels for the high cost firm. In the joint welfare maximisation with co-production case, the monopoly emerges exogenously as the firms choose to allocate all production to the lowest cost firm, however, the support of the governments ensures that the output will be set at the monopolistic level, and so will profits and welfare.

Special Case

When the consumption parameters in the above setting are equal to zero ($\gamma = 0, \zeta = 0$), the analysis focuses on the situation where the two producing countries consume none of their output. This is the situation described by Neary [61], which examines the policy measures set, when the assumption of symmetry in the seminal Brander and Spencer model [8] is relaxed. The main difference between the Brander and Spencer model [8] and the one described in this section is the existence of cost asymmetry between the producing firms and the fact that Brander and Spencer briefly describe cooperation in a set up where consumption does take place in countries 1 and 2 and the difference of my analysis compared to the Neary [61] analysis, stems from the fact that they also examine the case of the existence of social costs involved in the provision of the policy measures.

In this section therefore we analyse the three types of cooperational agreement under the no consumption framework. Note that as this is a special case of the general model described in the previous subsections, the description will not be as detailed, as this would only lead to duplication. Hence the analysis of the three types in turn is given in the following three sections.

Joint Welfare Maximisation (Type 1)

As previously mentioned, there are two stages in this game: in stage one governments set their optimal policy measures, through the maximisation of their joint welfare function and in stage one the firms set their optimal production levels given the policy measures of stage one. Using backward induction and using equations 2.50-2.57, when $\gamma = 0, \zeta = 0$,

the subsidies, profits and welfare levels set are given by the following functions:

$$s_1^J = \frac{-(a + 2c_1 + c_2)}{2} < 0 \text{ and } s_2^J = 0 \quad (2.101)$$

$$\Pi^J = \Pi_1^J + \Pi_2^J = 0 + \frac{(a - c_2)^2}{4b} \quad (2.102)$$

$$W^J = W_1^J + W_2^J = 0 + \frac{(a - c_2)^2}{4b} \quad (2.103)$$

Thus, as in the general case, the effect of the cooperation of the two governments in the asymmetric cost setting, is the creation of a monopoly; although the expectation from Brander and Spencer is the setting of policy measures so as to ensure output is set at a two firm monopoly level, the cost asymmetry leads to the exit of the high cost firm from the market and the establishment of the low cost firm as the producing monopolist. Note that the policy measures that achieve this outcome are a tax for the low cost firm and no measure for the exiting one, implying that the high cost firm is not given any incentives to participate in the production, whereas the low cost firm is taxed to reduce its production to the monopolistic levels. As no consumption is involved in this setting, the welfare function is given by the profits net of the policy measure bill, and thus the country that captures no production depicts zero welfare levels, whereas the country capturing all profits also captures positive high levels of welfare.

Co-production (Type 2)

This agreement type consists of three stages; the first sees the non-cooperational setting of the optimal policy measures, the second the bargaining over the possibility of a cooperative agreement between firms, in which the lowest cost firm will undertake the

total output production. In stage three, co-production takes place, with firms setting output through the maximisation of their sole profit function, given the policy measures they receive. Backward induction as described by Equations 2.58-2.82, allows us to define the following subsidisation level and subsequently the following profit and welfare function:

$$s_1^c = \frac{(\beta - 1)(a - c_2)}{2} < 0 \text{ and } s_2^c = \frac{-\beta(a - c_2)}{2} < 0 \quad (2.104)$$

$$\Pi^c = \frac{(a - c_2)^2}{16b} \quad (2.105)$$

$$W^c = \frac{3(a - c_2)^2}{16b} \quad (2.106)$$

The main observation is the fact that both firms, claiming ownership of full production in their respective country, are taxed. Thus, their effort to move away from the national champion role leads to their 'punishment', in the form of taxation, and therefore total profits are lower than the monopoly profits, in the case where only the lowest cost firm produces. This particular outcome is opposite to the claim by Horn and Persson [44], that competition policy (allowing for mergers) can be used as a substitute for strategic trade. In our setup this would be true if the subsidy levels proved to be zero, and thus a country instead of using the strategic trade approach, would allow competition policy to be used. This is not the case in the model described in this the model described in 2.3.3 both for the general and the special case, since firms are taxed for moving away from strategic trade.

Joint Welfare Maximisation with Coproduction (Type 3)

As in the type two, this agreement consists of three stages; in the first stage the governments, set their policy measures cooperatively, maximising their joint welfare function.

In the second stage, firms choose whether to cooperate in the setting of their output, through bargaining over the possible profits of such a move, in which the lowest cost firm will undertake the total output production. In stage three, co-production takes place, with firms setting output through the maximisation of their profit function, given the policy measures they receive.

Backward induction as described by Equations 2.83-2.98, allows us to define the following subsidisation, profit and welfare function levels:

$$s_1^{Jc} + s_2^{Jc} = 0 \quad (2.107)$$

$$\Pi^{Jc} = \frac{(a - c_2)^2}{4b} \quad (2.108)$$

$$W^{Jc} = \frac{(a - c_2)^2}{4b} \quad (2.109)$$

The relationship between the two policy measures ($s_1^{Jc} = -s_2^{Jc}$) shows that there is inter-dependency between these to such a degree that their sum equals zero, thus when the governments choose to cooperate in the setting where firms also cooperate, the policymakers do this in a way that the final outcome will be the monopoly one. In a way the policy measures cancel out, leaving the low cost firm to produce at the unprotected monopoly level, in contrast to the previous case, where the firms, wishing to disregard their role as national champions and move away from the wishes of the government, are 'punished' and left with lower production and profit levels.

2.3.4 Comparison of Cooperational and Non Co-operational agreements

The first main observation of the above analysis both under the consumption and the no consumption framework, is the fact that the role of the government is crucial for the outcome of the agreement. If the government does not participate as an agreeing partner, then the profits levels are lower than the monopoly ones, and thus such an agreement is not likely to be preferred by firms.

The following table (table 2), provides a summary of the profit rankings, as derived through Appendix B.2, based on the consumers' surplus parameters.

γ/ζ	0	1
0	$\Pi^{NC} > \Pi^J = \Pi^{Jc} > \Pi^c$	$\Pi^J = \Pi^{Jc} = \Pi^{NC} > \Pi^c$
1	$\Pi^{NC} > \Pi^J = \Pi^{Jc} > \Pi^c$	-

(Table 2: Profit Rankings)

Proposition 8 *The total profits realised by the firms operating in the three markets are always equal under the Jc and J regimes and greater compared to the c regime. Co-operative profits are always less than or equal to the non cooperative ones, depending on the consumption level in each country.*

Proof. In Appendix B.2 ■

In terms of welfare, the following table (table 3) provides a summary of the welfare rankings, as derived through Appendix B.3, based on the consumers' surplus parameters.

γ/ζ	0	1
0	$W^J = W^{Jc} > W^c > W^{NC}$	$W^{NC} = W^J = W^{Jc} > W^c$
1	$W^J = W^{Jc} > W^c > W^{NC}$	-

(Table 3: Welfare Rankings)

Proposition 9 *The total welfare levels realised by the firms operating in the three markets are always equal under the Jc and J regimes and greater compared to the c regime. Co-operative welfare levels are always greater than or equal to the non cooperative ones, depending on the consumption level in each country.*

Proof. In Appendix B.3 ■

Profits

In terms of the profits, one should note that firms are only indirectly interested in consumption, as the particular consumption levels define the policy measures they will be receiving, from their respective governments. The policy makers set these, when they aim at the maximisation of their objective functions comprising of profits, the subsidy bills and consumers' surplus. As observed from Proposition 8, when there is no consumption in either of the two markets ($\gamma = 0, \zeta = 0$), profits are greater when no cooperational agreement takes place, as in this situation, subsidization leads to higher output and higher profit levels. Also worth mentioning again, is the fact that joint welfare maximisation (J) and joint welfare maximization with coproduction (Jc) lead to the same profit levels.

We look at two situations where consumption is allowed to take place in the two producing countries; one is the case where there is full inward consumption for country 1 and no consumption for country 2 ($\gamma = 0, \zeta = 1$) and the second is the case where there is full inward consumption in country 2 and no consumption in country 1 ($\gamma = 1, \zeta = 0$). If country 2 captures total consumption, then both firms produce positive amounts and the non cooperative profits are greater than any of the cooperative regimes, as both firms will

be receiving higher policy measures, to enhance production in the presence of consumption in the two producing countries. The setting of consumption in country 2 with both firms producing, essentially is an altered Brander and Spencer model with two producing countries, and one consuming country, this being the cost efficient producing one. Firm 2 will produce for its domestic consumers, however the exporting strategic effect for the government in country 1 will imply positive output levels on the behalf of firm 1, in the non cooperative case.

One further observation to be made, in the case of full inward consumption by country 1, in which case the entire consumers' surplus is captured by country 1, then firm 1 finds it too costly to produce positive amounts, and thus is driven off the market and the firm in country 2 will be the one capturing the entire market as a monopolist. This can be attributed to the fact that any policy measures set in country 1, are set in such a way as to increase welfare that comprise of both profits and consumer's welfare. Thus in this situation the consumers' welfare effect is greater and so the government drives its firm off the market and allows the cost efficient firm to export in its market for consumption. Therefore, all production takes place in country 2, which produces at the monopoly level and consumption takes place in country 1. In terms of the cooperation profit level, the outcome is the lowest out of the three cooperative variations, as a result of the lack of government consent. This essentially implies that even in the non cooperative regime, only one firm, the cost efficient one emerges as the monopolist in the market.

Essentially the observation is, that the option preferred by the government is not in line with the option preferred by the firms, as the incentives of the two players may differ, particularly in the case where inward consumption is included in the analysis.

Welfare

Turning to welfare, in the no consumption analysis, the Brander and Spencer results regarding welfare, are confirmed even when asymmetry is assumed, as the Joint Welfare (J) is greater than the non-cooperational one. The two cooperative regimes that involve support on the policy setting by the government, lead to the realisation of the same levels of welfare, and the observation is that the coproduction agreement regime leads to the lowest level of cooperational welfare.

Moving to the analysis of the situations where consumption does take place, the observation is that the non cooperational outcome is the lowest in terms of welfare. If both countries compete in the output setting, acting as strategic rivals, when the high cost country captures the entire consumers' surplus ($\gamma = 0, \zeta = 1$), in order for the non cooperative welfare to be maximised, the low cost firm undertakes all production. In this case the welfare levels of the non cooperation regime equals those of the monopoly outcomes in J_c and J and the lowest welfare level is exhibited by the coproduction regime. Essentially, once countries have an interest in their own respective consumers additional to the profit captured in the third market, the subsidies received are also instruments of consumer welfare enhancement and policymakers are less likely to settle for higher profits to the expense of their consumers. When country 2 captures all CS , then no cooperation leads to the

lowest welfare level, since both firms will produce positive amounts, instead of opting for production rationalisation.

2.3.5 Decreasing Marginal Costs

The above analysis was based on the assumption of constant marginal costs for the two firms, with a cost asymmetry benefitting the firm in country 2. When this assumption is relaxed to allow for the marginal costs of the two producing rivals to decrease as the output increases ($\frac{d^2 C_j^i(Q_j^i)}{d^2 Q_j^i} < 0$), the robustness of the above conclusions will depend on the rate at which the cost schedules of the two firms decline. Thus, if the rate at which the marginal cost of firm one declines is lower than the corresponding rate for firm two, firm 2 continues to benefit from a cost advantage over the rival firm. Therefore the results of the above analysis will remain unaltered, although there will be greater cost synergies to be realised.

In the event, however, that the costs schedule of the firm in country 1 declines faster than the one in country 2, then conditional on the produced output, the cost advantage may be attributed to the firm in country 1. Thus the results in terms of the cooperational agreements may involve the firm in country 1 emerging as the monopolist. The following paragraphs deal with the effect of decreasing marginal costs for each of the three types of co-operational agreements.

In order to visualise the outcome of this argument, a basic model of decreasing marginal costs is used, and for simplicity reasons, a framework without consumption is adopted. We use a simple form of the cost function assumption in Fisher [34], as seen in

Equation 2.5

$$C_j(Q_j^i) = c_j Q_j^i + \frac{1}{2} d_j (Q_j^i)^2$$

where $d_j < 0$ and therefore the marginal cost is given by: $\frac{dC_j^i(Q_j^i)}{dQ_j^i} = c_j + d_j Q_j^i$ (Equation 2.6) and the second order condition $\frac{d^2 C_j^i(Q_j^i)}{d^2 Q_j^i} = d_j < 0$.

Maintaining the assumption of the constant marginal cost setting, where $c_1 > c_2$, the cost efficiency of the two firms depends on the decreasing rate, d_1 and d_2 . If $d_2 < d_1 < 0$, according to the above cost function, firm 2 maintains its costs advantage. The more interesting situations arise, however, when $d_1 < d_2 < 0$, as this can imply that firm 1 may be the cost efficient firm, depending on the level of the market size.

In more detail the following sections examine the outcomes of the non cooperational and co-operational regimes, under the assumption of decreasing marginal costs.

No Cooperation

The non cooperative outcome in terms of profits and welfare, when governments maximise their individual welfare functions and firms set output maximising their individual profits functions as per the analysis in equations 2.26-2.46 are summarised through the following functions:

$$\begin{aligned} \Pi^{NC} = & \frac{kf[k(b^2(2c_1 - 3c_2) - c_2g + b(c_1d_2 - 2c_2h) + a(b^2 + g + b(d_1 + h))^2)]}{A} \\ & + \frac{kf[f(b^2(2c_2 - 3c_1) - c_1g + b(c_2d_1 - 2c_1h) + a(b^2 + g + b(d_2 + h))^2)]}{A} \end{aligned} \quad (2.110)$$

$$W^{NC} = \frac{(2b^2 + g + 2bh)[k(b^2(2c_1 - 3c_2) - c_2g + b(c_1d_2 - 2c_2h) + a(b^2 + g + b(d_1 + h))^2)]}{A} + \frac{(2b^2 + g + 2bh)[f(b^2(2c_2 - 3c_1) - c_1g + b(c_2d_1 - 2c_1h) + a(b^2 + g + b(d_2 + h))^2)]}{A} \quad (2.111)$$

where $A = 2(5b^4 + g^2 + 10b^3h + 4bgh + b^2(4d_1^2 + 13h + 4d_2))^2$, $k = 2b + d_1 > 0$, $f = 2b + d_2 > 0$, $h = d_1 + d_2$, $g = d_1d_2 > 0$, assuming $2b + d_2 > 0$ and $2b + d_1 > 0$.

This assumption ensures that at least one firm will produce positive output levels.

Cooperation

Case 1: The marginal cost schedule of firm 2 declines faster than the equivalent for firm 1 ($0 > d_1 > d_2$)

This situation essentially implies that the cost advantage of firm 2, at low levels of production, established by the fact that $c_1 > c_2$, is maintained for all levels of production and firm 2 is chosen as the monopolist for all cooperational regimes. In summary,

	J	c	Jc
Subsidy levels	$s_1^J = \frac{-bc_2 + 2bc_1 + c_1d_2 - a(b+d_2)}{2b+d_2}$ $s_2^J = 0$	$s_1^c = \frac{(a-c_2)(\beta-1)}{2}$ $s_2^c = \frac{-\beta(a-c_2)}{2}$	$s_1^{Jc} + s_2^{Jc} = 0$
Profits	$\Pi^J = \frac{(a-c_2)^2}{2(2b+d_2)}$	$\Pi^c = \frac{(a-c_2)^2}{8(2b+d_2)}$	$\Pi^{Jc} = \frac{(a-c_2)^2}{2(2b+d_2)}$
Welfare	$W^J = \frac{(a-c_2)^2}{2(2b+d_2)}$	$W^c = \frac{3(a-c_2)^2}{8(2b+d_2)}$	$W^{Jc} = \frac{(a-c_2)^2}{2(2b+d_2)}$

(Table 4: Firm 2 Monopoly Summary for $d_1 > d_2$)

Case 2: The marginal cost schedule of firm 1 declines faster than the equivalent for firm 2 ($d_1 < d_2 < 0$)

This relationship between the slopes of the Marginal Cost Curves, implies that firm 2 will not necessarily be the cost efficient firm, and thus will not be chosen as the serving monopolist; this efficiency will depend on the actual market size. This can be illustrated through the use of a graph. Under the decreasing marginal cost assumption, total costs increase at a lower rate for firm 1 compared to firm 2, thus although for low values of output firm 2 maintains the cost efficiency, above a certain threshold, firm 1 becomes the lowest cost firm.

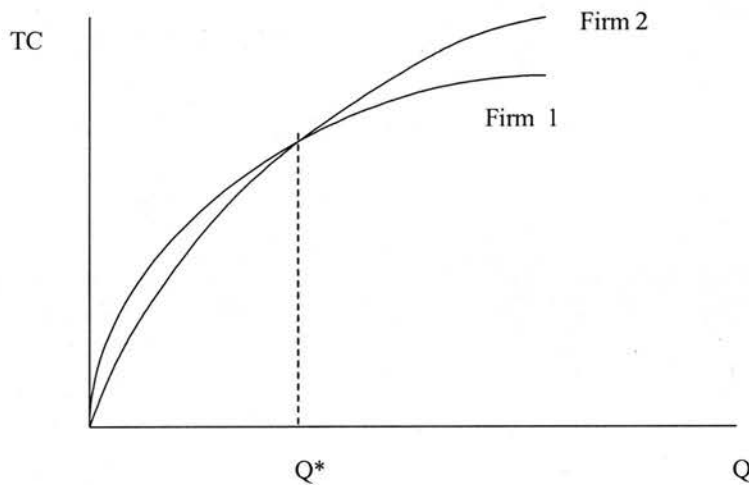


Figure 1: Cost Efficiency Switch

Thus for quantities produced above Q^* , firm 1 produces at a lower cost. We need to define this level of Q^* and then compare that with the monopoly production level of firm 2, to define that market size that makes the choice of firm 1 as the monopolist efficient.

The output level Q^* is given by the intersection of the two average cost curves AC_1 and AC_2 :¹⁵

$$c_1 + d_1 \frac{Q^*}{2} = c_2 + d_2 \frac{Q^*}{2}$$

\Rightarrow

$$Q^* = \frac{2(c_1 - c_2)}{d_2 - d_1}$$

The comparison of this threshold value with the maximum output (monopolist level output) of firm 1 under each regime establishes the critical market sizes for firm 1 to become the monopolist, as per *Definition 1*.

Definition Denote a^J, a^c, a^{Jc} the critical market sizes, such that for markets larger than these, firm 1 becomes the monopolist in regimes J, c, Jc respectively.

The following sections describe these critical values with respect to each regime in more detail, in order to establish the policy measures, profits and welfare under each cooperative regime.

Joint Welfare Maximisation (Type 1)

Under the constant marginal costs assumption, for the joint welfare maximisation, as already observed, the firm with the lowest cost will prevail as the monopolist. If decreasing marginal costs are introduced in the analysis, the rate of this decrease is essential in the establishment of the outcome. Therefore, when $d_1 < d_2$, the conditions for firm 1 to be the monopolist in the market are described by the next Proposition, Proposition 10.

Proposition 10 *The joint welfare maximisation outcome is the establishment of a monopolist in the market, that will serve the third market. This monopolist will be: (1) Firm 1,*

¹⁵ Note that this point provides the critical value of output for increasing returns to scale.

for a large market, given by a high a , a small cost gap level $(c_1 - c_2)$ and a large rate of marginal cost decline for country 1, d_1 or (2) Firm 2, otherwise.

The threshold value of the market size for firm 1 to become the monopolist in the market is given by

$$a > a^J = c_2 - \frac{2b(c_1 - c_2)}{d_1}$$

Proof. In Appendix B.4 (with focus on (ii)) ■

Therefore, the observation is that for a small market, a high cost asymmetry gap level and a small rate of the marginal cost curve decline for the firm in country 2, the firm in country 2 will undertake all production. Essentially, the cost asymmetry gap is great and although the rate of the MC curve decline is small, the overall effect still leaves the firm in country 2 as the cost efficient one, thus this becomes the monopolist. If on the other hand, we have a large market, a small cost gap level and a large rate of marginal cost decline for country 1, the results are reversed and firm 1 undertakes all production.¹⁶

The following table summarises the obtained levels of subsidies, output, profits and welfare when in the first case firm 1 or in the second case, firm 2 is the monopolist in the market. Column 1 describes the firm that is the monopolist in the market, column 2 provides the policy measures for both firms under each of the two cases, column 3, the

¹⁶ Note that for these particular values of the parameters, the non negativity constraints for positive production imposed by firms in stage 2 also hold:

$$\begin{aligned} Q_1^J &\succeq 0 \\ \Rightarrow bs_2 - (2b + d_2)s_1 &\succeq ab - 2bc_1 + bc_2 + ad_2 - c_1d_2 \\ \\ Q_2^J &\succeq 0 \\ \Rightarrow bs_1 - (2b + d_1)s_2 &\succeq ab - 2bc_2 + bc_1 + ad_1 - c_2d_1 \end{aligned}$$

output levels, column 4 the profits levels and finally column 5 the welfare levels.

Monopolist	Subsidies	Output	Profits	Welfare
<i>Firm 1</i> (for $a > a^J$)	$s_1^J = 0$ $s_2^J = \frac{-bc_1 + (2b+d_1)c_2}{2b+d_1}$ $\frac{-a(b+d_1)}{2b+d_1}$	$Q_1^J = \frac{a-c_1}{2b+d_1}$ $Q_2^J = 0$	$\Pi_1^J = \frac{(a-c_1)^2}{2(2b+d_1)}$ $\Pi_2^J = 0$ $\Pi^J = \frac{(a-c_1)^2}{2(2b+d_1)}$	$W_1^J = \frac{(a-c_1)^2}{2(2b+d_1)}$ $W_2^J = 0$ $W^J = \frac{(a-c_1)^2}{2(2b+d_1)}$
<i>Firm 2</i> (for $a < a^J$)	$s_1^J = \frac{-bc_2 + (2b+d_2)c_1}{2b+d_2}$ $\frac{-a(b+d_2)}{2b+d_2}$ $s_2^J = 0$	$Q_1^J = 0$ $Q_2^J = \frac{a-c_2}{2b+d_2}$	$\Pi_1^J = 0$ $\Pi_2^J = \frac{(a-c_2)^2}{2(2b+d_2)}$ $\Pi^J = \frac{(a-c_2)^2}{2(2b+d_2)}$	$W_1^J = 0$ $W_2^J = \frac{(a-c_2)^2}{2(2b+d_2)}$ $W^J = \frac{(a-c_2)^2}{2(2b+d_2)}$

(Table 4: Joint Welfare Maximisation)

The observation is therefore, that in both cases, the policymakers identify the lowest cost firm, and set the measures in such a way that the high cost firm is taxed to be driven off the market, and the cost efficient firm undertakes all production, with a zero policy measure. This is the case as no further policy measure is required, in the absence of consumers.

Coproduction (Type 2)

Agreements on coproduction, as introduced in section 2.3.3, are based on the assumption that the lowest cost firm will undertake all production, hence serving all the markets. The cost advantage of the two firms defined through the market size yields the optimal choice for the monopolist to undertake all production under the coproduction regime. Thus for $d_1 < d_2$, we have:

Proposition 11 *Firm 1 is the lowest cost firm and therefore the monopolist under a coproduction agreement for a market size $a > a^c$.*

Proof. In Appendix B.5 ■

Following the analysis described in equations 2.58-2.82 yields the following levels of subsidisation, profits and welfare, as summarised in Table 5:

Monopolist	Subsidies	Profits	Welfare
<i>Firm 1</i> (for $a > a^c$)	$s_1^c = \frac{(a-c_1)(\beta-1)}{2}$ $s_2^c = \frac{-\beta(a-c_1)}{2}$	$\Pi^c = \frac{(a-c_1)^2}{8(2b+d_1)}$	$W^c = \frac{3(a-c_1)^2}{8(2b+d_1)}$
<i>Firm 2</i> (for $a < a^c$)	$s_1^c = \frac{(a-c_2)(\beta-1)}{2}$ $s_2^c = \frac{-\beta(a-c_2)}{2}$	$\Pi^c = \frac{(a-c_2)^2}{8(2b+d_2)}$	$W^c = \frac{3(a-c_2)^2}{8(2b+d_2)}$

(Table 5: Coproduction)

Joint welfare Maximisation with Coproduction (Type 3)

As mentioned above, the choice of the producing monopoly firm for decreasing marginal costs is more complicated than the case of constant marginal costs. Thus, using the same decreasing cost assumption described by Equation 2.5, the following proposition, yields the optimal levels of market size for the choice of the monopolist.

Proposition 12 *Firm 1 is the lowest cost producer and thus is chosen as the monopolist firm under a joint welfare maximisation with coproduction agreement when $a > a^{Jc}$.*

Proof. In Appendix B.5 ■

Following the analysis described in equations 2.83-2.98 yields the following levels of subsidisation, profits and welfare, as summarised in Table 6:

Monopolist	Subsidies	Profits	Welfare
Firm 1 (for $a > a^{Jc}$)	$s_1^{Jc} + s_2^{Jc} = 0$	$\Pi^{Jc} = \frac{(a-c_1)^2}{2(2b+d_1)}$	$W^{Jc} = \frac{(a-c_1)^2}{2(2b+d_1)}$
Firm 2 (for $a < a^{Jc}$)	$s_1^{Jc} + s_2^{Jc} = 0$	$\Pi^{Jc} = \frac{(a-c_2)^2}{2(2b+d_2)}$	$W^{Jc} = \frac{(a-c_2)^2}{2(2b+d_2)}$

(Table 6: Joint Welfare Maximisation with Coproduction)

Cooperational Agreements Summary and Comparison

Table 7 provides a summary of the profit and welfare rankings:

Market size	Regime	Monopolist	Profit Ranking	Welfare Ranking
$a > a^c > a^{Jc} > a^J$	J	Firm 1	$\Pi^J = \Pi^{Jc} > \Pi^c$	$W^J = W^{Jc} > W^c$
	c	Firm 1		
	Jc	Firm 1		
$a^c > a > a^{Jc} > a^J$	J	Firm 1	$\Pi^J > \Pi^c > \Pi^{Jc}$ or*	$W^J > W^c > W^{Jc}$ or*
	c	Firm 1		
	Jc	Firm 2	$\Pi^J > \Pi^{Jc} > \Pi^c$	$W^J > W^{Jc} > W^c$
			*depending on the rates d_1 and d_2	
$a^c > a^{Jc} > a > a^J$	J	Firm 1	$\Pi^J > \Pi^{Jc} > \Pi^c$	$W^J > W^{Jc} > W^c$
	c	Firm 2		
	Jc	Firm 2		
$a^c > a^{Jc} > a^J > a$	J	Firm 2	$\Pi^J = \Pi^{Jc} > \Pi^c$	$W^J = W^{Jc} > W^c$
	c	Firm 2		
	Jc	Firm 2		

(Table 7: Cooperational Profit Ranking)

Therefore the descriptions the previous sections can be summarised by the following proposition:

Proposition 13 *If $d_1 > d_2$, firm 2 is the cost efficient firm and thus will be the monopolist regardless of the market size and the cooperational regime. The profit and welfare rankings are:*

$$\Pi^J = \Pi^{Jc} > \Pi^c$$

$$W^J = W^{Jc} > W^c$$

If $d_1 < d_2$, the cost efficient market structure depends on the size of the market and the regime.

Proof. In Appendix B.6 ■

The most important observation derived from table 7, is the fact that in the two cases where either firm 1 or firm 2 is the monopolist in the market, both for profit and welfare levels, the rankings coincide. In the cases, however, where for a particular market size, different cooperational regimes lead to different monopoly firms, then the ranking no longer involves equality and thus Jc and J do not provide the same profit and welfare levels. This stems from the fact that, as seen in appendix 6, the comparison between profits or welfare under these two particular regimes will differ due to the cost asymmetry. Particularly, for $a^c > a > a^{Jc} > a^J$, the relative values of the decreasing element of the cost function d_1 and d_2 , will establish whether Jc is preferred to c , for both profits and welfare.

Cooperative vs Non Co-operative outcomes

In order for the ranking to be completed, there is the necessity to also compare the above results to the non cooperative outcomes. Table 8 in Appendix B.7 provides a summary of the rankings. The observation is that if $d_1 > d_2$, firm 2 is the cost efficient firm and thus will be the monopolist regardless of the market size and the cooperational regime. The profit rankings depend on the relative value of d_2 and will display higher levels of non cooperational profits compared to the cooperative ones when d_2 is low and higher cooperative levels compared to the non cooperative ones otherwise. If $d_1 < d_2$, the cost efficient market structure depends on the size of the market and the regime. Once more however

the ranking depends on the relative values of d_1 and d_2 , and the size of the market. As in the above case, higher levels of non cooperational profits compared to the cooperative ones exists when d_1 is low and higher cooperative levels compared to the non cooperative ones otherwise.

Proposition 14 establishes the rankings between cooperative and non cooperative profits, depending on the values of the two decreasing rate parameters, d_1 and d_2 , which, along with the market size, play a defining role in the ranking. Therefore:

Proposition 14 *If $d_1 > d_2$, firm 2 is the cost efficient firm and thus will be the monopolist. The profit rankings depend on the relative value of d_2 . For low d_2 higher levels of non cooperational profits compared to the cooperative ones are observed and for high d_2 otherwise.*

If $d_1 < d_2$, the cost efficient market structure depends on the size of the market and the regime. Once more however the ranking depends on the relative values of d_1 and d_2 , and the size of the market. As in the above case, low d_1 leads to higher levels of non cooperational profits compared to the cooperative ones and high d_1 to lower.

Proof. In Appendix B.7 ■

Turning the analysis to the welfare rankings, Table 9 in Appendix B.8 provides a summary of the welfare rankings. The observation from this is that if $d_1 > d_2$, firm 2 is the cost efficient firm and thus will be the monopolist regardless of the market size and the co-operational regime. The rankings will display higher levels of cooperational welfare compared to the non cooperative, for all market size levels and for all variations of the

d_2 parameter. If $d_1 < d_2$, the cost efficient market structure depends on the size of the market and the regime. The rankings will display higher levels of cooperational welfare compared to the non cooperative, for all market size levels and for all variations of the d_2 parameter. Proposition 15 provides a summary of the behaviour of the welfare levels under each regime.

Proposition 15 *If $d_1 > d_2$, firm 2 is the cost efficient firm and thus will be the monopolist. Cooperational welfare levels are always greater than non cooperational levels.*

If $d_1 < d_2$, the cost efficient market structure depends on the size of the market and the regime. Cooperational welfare levels are always greater than non cooperational levels.

Proof. In Appendix B.8 ■

The rankings of both cooperative and non cooperative profits therefore show that the relative value of the decreasing factor defines these, as the higher the value of this parameter, the lower the non cooperative profits compared to the cooperative ones. This can be attributed to the fact that cost synergies, realised mainly through the decreasing element of the cost function, can be exploited more efficiently by a monopolist, rather than a duopoly where one firm is more cost efficient. In welfare terms, the observation is that the decreasing element does not influence the outcome, and therefore, non cooperational welfare levels will always be lower than the cooperational ones.

2.3.6 Comparison Constant Versus Decreasing Marginal Costs

The comparison is based on the profits and welfare levels when no consumption takes place in the two producing countries, under both cost regimes. The main observation when these regimes are compared is the fact that production rationalisation, where the lowest cost firm undertakes all production, is the outcome of the joint welfare maximisation for both constant and decreasing marginal costs. When, either firm 1 or firm 2 is the sole producer, serving all markets, low values of the decreasing element of the cost function lead to the same profit ranking, where the non co-operational profits are higher than all the co-operational levels ($\Pi^{NC} > \Pi^J = \Pi^{Jc} > \Pi^c$). For high values of the decreasing element, however, the co-operational profits, where one firm becomes the monopolist and thus can exploit the full benefits from the cost synergy, will be greater than the non co-operational ones ($\Pi^J = \Pi^{Jc} > \Pi^c > \Pi^{NC}$). In a similar manner, when firm 1 is the cost efficient firm, under certain market size levels and for some of the co-operational regimes and firm 2 under other regimes, the observation is that the above conclusion holds, in terms of the comparison between Π^{NC} and the cooperative profits. The difference stems only in the ranking of the cooperative profit levels, as when firm 1 is the monopolist under J and c and firm 2 under Jc , then Π^J is the highest level, however the choice between Π^{Jc} and Π^c can go in either direction.

In terms of welfare, the rankings under the constant and the decreasing marginal costs do not change and therefore, $W^J = W^{Jc} > W^c > W^{NC}$, implying that non cooperative outcomes are not preferred by the policy makers, as the high subsidy bills lead to lower overall welfare levels.

2.4 Concluding Remarks

The aim of the analysis undertaken above was to examine any potential cooperational schemes that could arise in a strategic trade policy framework as introduced by Brander and Spencer [8] when the two rival countries differ in their production costs.

Three cases were examined, one in which the governments decide to cooperatively maximise their objective functions and thus set the subsidies at lower levels than those prevailing in the non cooperational case. The two remaining cases involve the effort of firms to cooperate and in this way create a single international monopoly, and the decision of governments to either not cooperate or jointly maximise their objective functions to set their optimal protectionist measures. In both cases, these turn out to be taxes, as the firms deviate from their roles as national champions.

A linear case approximation, both for the case of constant and decreasing marginal costs was adopted in order to examine the ranking in terms of welfare and profit levels for each potential level of cost asymmetry and consumption level.

Firstly, under both the cases of constant and decreasing marginal costs, the joint welfare maximisation regime leads to the establishment of the lowest cost firm as a monopolist serving all the markets. Welfare rankings are not altered when we move from the constant to the decreasing marginal cost regime, and cooperative regimes lead to greater welfare levels, relative to the non cooperative ones.

Also, in terms of profit rankings, in general, under both regimes, non cooperative profits are greater than the co-operational ones. Particularly for the constant marginal costs regime, Π^{NC} is greater than the co-operational profits, both for the case where no inward

consumption takes place and when country 2 consumes total production. In the case, however, where country 1 consumes all production, then the raking of profits takes the following form: $\Pi^{NC} = \Pi^J = \Pi^{Jc} > \Pi^c$.

Thus the examination has allowed us to rank both profit and welfare levels and we are lead to the conclusion that governments will always prefer any form of co-operational agreement to setting their policy measures non cooperatively, whereas the firms will always prefer that non cooperative regimes, as these lead to the setting of higher levels of policy measures and therefore profits.

Chapter 3

MNCs, Entry Modes and Asymmetric Information-The Role of Government Intervention

3.1 Introduction

UNCTAD in its 2009 investment report [74] highlights the effect of the recent economic crisis on global FDI flows. The foreign investment scene has undergone significant changes, as for 2008 the share of global FDI flows towards developing and transition economies increased, while the FDI flows towards developed countries declined. The choice of FDI mode by multinational corporations has also been affected by the crisis. The 2009 report states that although greenfield investments appeared resistant in 2008, they were affected negatively in a significant way in the following year. Cross-border mergers and M&As declined both in 2008 and 2009, however UNCTAD expects a recovery in the coming years. This is in contrast to the findings of the 2006 report [73], where for the year 2005 the great increase in FDI flow was attributed to mergers and acquisitions and the greenfield investment level declined. European and global M&As for 2005 displayed an increase of 40%. The 2009 report mentions that cross border deals for Europe declined by 56%.

These changes in the foreign investment landscape lead to modifications of the policies adopted both on a national and an international level. The same report for 2009 gives an account of altogether favourable trends for FDI during the crisis (2008 and 2009), mainly

through changes in tax regimes and FDI favourable measures aiming to promote investment. However, as the report states ‘there are also signs that some countries have begun to discriminate against foreign investors and/or their products in a ‘hidden’ way using gaps in international regulations’ ; forms of ‘covert’ protectionism have emerged, examples of which include favouring of products with high ‘domestic’ content in government procurement.

The above paragraph emphasizes the role the policy maker has to play in the choice of the entry mode a multinational firm will adopt when wishing to gain access in its market. The setting of a policy measure may increase or decrease the attractiveness of the firm’s optimal entry mode. Motivated by the above observation, the following chapter will look at the potential incentives of a host country’s government to offer policy measures in an effort to influence the entry mode decision of a foreign firm.

Nocke and Yeaple [64] suggest that ‘it would be interesting to compute the welfare implications of various policy experiments, such as restrictions on cross-border acquisitions or greenfield FDI’.

The main idea explored in this chapter of my thesis evolves around the choice of entry mode by a firm wishing to enter a market, in the presence of information asymmetry. The domestic firms in the host market have full information regarding the market demand, whereas the entering firm does not. It is only able to obtain this information when its entry mode choice involves the acquisition of an already existing firm in the market. This same analysis was first introduced by Qiu and Zhou [68], who analyze the incentives for the creation of cross border mergers under the existence of informational asymmetry. When a

foreign firm wishes to enter a host market, it may choose brownfield investment, as this allows the elimination of the informational asymmetry. The model described in this chapter differs from the Qiu and Zhou model, not only in the possible entry mode options, which include Greenfield investment, acquisition and exports, but also in the government intervention, when the host policy maker wishes to influence the entry mode choice, when the firm opts for entry through one of the possible entry mode options.

The following analysis consists of a review of the relevant literature in Section 3.2, followed by the description of the assumptions and model set up in Section 3.3. Sections 3.4 and 3.5 provide the analysis under the symmetric and asymmetric information conditions respectively. The optimal policy measures and the equilibrium derivations are undertaken in Section 3.6. Section 3.7 concludes. Appendix C provides supporting proofs.

3.2 Literature Review

The literature on international market entry by Multinational Enterprises (MNEs) focuses on various parameters that may influence the entry, such as the potential entry mode options available and policy measures adopted.

Some of the most seminal papers, closely related to the topic of my analysis have been written by Horstmann and Markusen [45],[46],[47],[48]. The following paragraphs give an overview of those models closest to the topics of this chapter's research.

Horstmann and Markusen (H&M) [45] analyze the decision of a multinational firm on its entry mode, mainly focusing however, on what Harzing [41] would describe as non equity entry modes. Harzing [41] distinguishes between the acquisition and licensing based

on type of equity; licensing is considered to be a 'non-equity' type of entry mode, whereas the acquisition of a firm that is already operating in the host market is an equity option, and the foreign firm becomes the owner of the local company. The entry mode options in the H&M model originally include Greenfield investment or serving through the licensing of the production to an existing domestic to the host market firm but later allow for exporting. Compared to the options introduced for the analysis of this chapter of my thesis, it can be observed that although the first two options are identical to the ones used in Horstmann and Markusen, the licensing option resembles, but is not exactly the same as the option of acquisition used in the model described in the following analysis. Essentially, in this chapter, two of the options involve ownership of a locally operating firm (Greenfield FDI and acquisition) and are therefore equity based and only one non equity option (exporting). This is in contrast to the model by H&M, which presents two non equity (exporting and licencing) and one equity option (Greenfiled FDI). Horstmann and Markusen aim to explore the theory of knowledge based firm specific asset transfer and focus on potential issues arising from the 'public goods' ¹⁷ property of assets, particularly knowledge based ones, during their transfer. The reputation of the MNE associated with the maintainance of high product quality, through its production technology is considered as the transferrable asset. This is transferred to a market characterised by information asymmetry in the form of costly supervision of the licensee. The multinational firm, using this technology-asset has the ability to produce both high and low quality products, while the host country firms are only able to produce low quality products. If licensing is chosen as the entry mode, there is

¹⁷ As Horstmann and Markusen [45] mention this property is related to the fact that some assets can be 'supplied to additional production facilities at a very low cost'.

a risk associated with the maintenance of the reputation of the multinational as the producer of the high quality product, which can be mitigated through either costly incentives paid to the licensee or the set up of a fully owned subsidiary in the host market. FDI as the entry mode choice allows for the transfer of the asset without the risk of a reduction in the product quality. In the absence of potential cost advantages linked with the operation of a licensee, such as economies of scope, the optimal entry mode choice for the foreign firm is FDI, as the requirement for incentives to be given to the licensee for quality maintenance makes licencing too costly. When gains can be realized through licensing, then other factors, such as the market size, the level of the economies of scope, will also affect the mode choice. It should be noted that there is similarity to the model described in the following sections, in that, when the local firm has a knowledge advantage over the entering firm, the decision depends on a number of factors, including the cost level, the number of host country operating firms, the market size, as seen in later sections.

The option of exporting is also introduced in the model as an alternative to other forms of foreign activities, however, to enable this extension the authors introduce an assumption of demand growth. The main difference in this setting, compared to the following analysis, is the fact that the model Horstmann and Markusen present is dynamic and involves a number of periods of production. Thus time enters in the analysis and is a significant measure in defining the optimal entry mode. The Horstmann and Markusen [45] model concludes that ‘as the market size changes, the MNE may switch from FDI to licensing or from exporting to some form of foreign operations. However, the MNE will never switch from licensing to FDI’.

Horstmann and Markusen [45] also analyze the role of the government and the incentives it may have to use particular measures to affect the outcome of the firm's decision. The examination of trade policy measures is based on the assumption that the marginal cost is the same under both the licensing and the FDI option, whereas the marginal cost in the case of exporting is higher as a result of the existence of transportation costs. Note that the main difference with my model is the fact that all the featured measures are based on restricting the use of a particular entry mode whereas we look at how particular measures are used to influence the switch from one entry mode to another. One can perceive the measures in this paper as more direct; if the host government would not want FDI to be chosen, it ensures that this is the case through banning the particular option. The measures that are used in the following analysis are less direct; the firm still has the option of a choice between its optimal entry mode and that of the government depending on the actual level of the measure used. In their model, when FDI is banned, licensing improves welfare compared to exporting as the host country both captures rents that would otherwise accrue to the multinational and the price of the good does not change. When importing is banned, through the setting of a sufficiently high tariff, the welfare of the host country increases more if licensing is chosen rather than FDI. When taxation is used, as a penalizing tool, then a profits tax on FDI improves welfare if it does not create a mode switch to exporting. Licensing will imply that some of the profits will be captured by the host country. If FDI production output is taxed, there are two conflicting effects for the host country welfare; one is the deadweight loss from the marginal cost increase and thus the decrease of output

and the second is the tax payment captured by the host government. The effect on the host country welfare depends on the extend of the two effects, should FDI be chosen.

Similarly, Horstmann and Markusen [48] aim to analyse the endogenous determination of the market structure in a host country, through the plant location choice by the potential MNE entrant, in addition to the effect of trade policies adopted, to the endogenous market structure. A two country framework is adopted, allowing the existence of 'at most two firms in the relevant markets, one from each country', assumed to have access to identical technologies and costs. As in the previously discussed paper by the same authors, firms incur both firm and plant specific costs when first entering the market, however, should the firm wish to set up any additional plants then it only has to forgo the plant specific costs. A main deviation from the previous model analyzed by the same authors is the existence of identical constant marginal costs for both countries and the firm operating; additionally, should a firm choose to serve a market through exports, then it has to incur a transportation cost. The two options available to the firms for entry in a market is the set up of a new plant (FDI) or exporting; they also have the option of no entry. The model refers to a two stage game; stage one involves the choice by the firm between no entry, exporting (serving both countries from one plant) and Greenfield FDI (building plants in both countries). In stage two, the two firms make their production choice as Cournot duopolists. They employ particular numerical examples in order to demonstrate the likely structure outcomes, which prove the existence of a relationship between the firm and plant specific costs and the equilibrium market structure. Simulation has been used to define the different boundary conditions for the emergence of each market structure, followed by comparative statics

analysis. This resembles the analysis of this chapter of my thesis where the relationship between the main variables involved, namely the transportation and the Greenfield cost etc. will define the equilibrium outcome. Through a simple simulation exercise the following model also seeks to establish how changes in the variable values, affect the game outcome. H&M distinguish between the plant specific cost (G) paid for every new plant established and the firm specific cost (F) incurred once, related to the firm specific asset. The results of Horstmann and Markusen [48] can be summarized in the following; for an exogenously given level of the transportation cost, multinational activity increases and therefore both firms operate plants in both countries, when the firm specific cost (F) is high relative to the plant cost (G). When the firm specific cost (F) exceeds a certain threshold, then a monopoly MNE arises, operating two plants and one firm does not enter. If on the other hand the plant specific cost (G) is higher relative to the firm specific cost (F), exporting is chosen as the equilibrium entry mode, and similarly to the previous situation, if the plant cost is sufficiently high, then asymmetric monopoly MNEs arise.

Following the firm choice setting, M&H [48] turn their focus on the welfare impact of these decisions. Similar simulation techniques reveal that Pareto optimality is reached when both firms operate two plants, one in each country and this structure is superior to the exporting outcome. Following their welfare analysis, they examine the effect of trade policy measures such as tariff or production tax/subsidies when the market structure is endogenous. Their analysis shows that small alterations in the tax levels can lead to substantial welfare changes as they may be mode switch inducing, therefore altering the

market structure. They conclude that manipulating the market structure through the setting of different policy measures can serve as a tool of public policy in itself.

Therefore, in Markusen and Horstmann [48], the introduction of a policy measure can lead to a change in the market structure through a change in the entry mode and in this way affect the profit and welfare levels. Similarly, in this chapter of my thesis, when the number of entry options increase to three, as the brownfield investment option is included, the market structure can be affected, when the government of the host country sets intervening measures. Numerical examples are used to define the equilibrium outcomes, when the government provides incentives for a switch from the firm's optimal to the government's optimal entry model.

Firm specific assets leading to ownership advantages that a MNE can exploit when entering in a host market, are analyzed by Horstmann and Markusen [47]. These, mainly knowledge-based assets, create cost advantages for the multinational, which can be exploited when entering a new market. The model described in this paper involves the creation of an asset that leads to multi-plant economies of scale for the firm. In my model, I do not focus on the characteristics leading to the cost advantage of entering firm, but rather, in line with Albornoz et al [1], I assume that it has a cost advantage that it can transfer when entering the foreign market, even under an acquisition framework. It can be however argued that this advantage is a result of the ownership of transferable asset as in Horstmann and Markusen. In my model, I include a general cost of opening a new plant in the new market, denoted by G , whereas H&M [48] ,[47] base their model in the distinction between the plant specific cost (G) and the firm specific cost (F) related to the firm specific

asset. The firm only incurs the F cost once, but will incur the G cost every time it sets up a new plant. Note that, as I am describing a case where the n firms in the host market are already operating and the foreign firm has been operating in its own market, there is only requirement for the plant set up cost if the firm chooses to enter through FDI. This can be perceived as a situation where the F cost has already been incurred in the past and has led to the cost advantage for the MNE. Note that the H&M [47] model allows for more than one producer operating in the foreign country (host), compared to my assumption of a monopolist MNE, and the model examines potential entry through exporting or Greenfield FDI. Both these options are used in my model. The paper examines the welfare of the host country (foreign) and the home country (MNE country of origin). In terms of the home firm (MNE), it is always preferable for the firm to enter the host market, either through FDI or exporting rather than not to enter at all. The host country may find that there are gains from the operation of a multinational firm; this is observed when its market is too small to support a domestic firm. Also, when there is sufficient competition in the host market to ensure that the multinational, does not hold too much monopoly power, as a result of its cost advantage and the price of the good is reduced. The MNE can potentially lead to losses for the host market, if its entrance drives out a profitable firm in the host market.

The analysis does not include the examination of the potential role the government may play in the choice of an entry mode for the MNE. The potential losses for the host country could be reversed should the policy maker choose incentivisation measures, as examined in this chapter of my work.

Horstmann and Markusen [46] construct a model that allows for the emergence of an MNE as an equilibrium phenomenon, by endogenising the MNE entry decision, based on production and transportation technology conditions. The assumptions for the analysis are similar to the above described model by the same authors, with time playing a significant role in the equilibrium outcome. All firms make entry decisions based solely on host-country demand and a number of further simplifying assumptions allow for the examination only of situations where the entry of a multinational firm creates competition between the multinational firm and local host-country producers. The first of the two cases examined here allows for a demand high enough to support the set-up of only one plant in the host market, whereas the second allows at most two plants. In the second part they assume a large number of host country producers that have access to the same technology as the MNE.

The main point of the model is the establishment of time thresholds for the entry choice decision. In the H&M [46] model, the host country will be served by the MNE either through exports or Greenfield FDI but not through the acquisition of a domestically owned firm, as this option is not considered. The entry mode chosen is in this model dependent on the entry time; the time of investment as well as the magnitudes of the parameters involved namely the Greenfield investment cost G the firm cost F and the transport cost s define the strategy chosen, as these define the potential switch time from one entry mode to another. The analysis concludes that an MNE will enter a market through a plant set-up when the export cost and the firm specific cost are large enough compared to plant economies of scale.

The model analyzed in this chapter of my thesis is closely related to two papers in the merger literature, namely Alborno et al [1] which focuses on the entry decision of firms, when the two options for international operation is greenfield investment or mergers and acquisitions and Qiu and Zhou [68] that examine the potential of information mergers when the host country market is characterized by informational asymmetry.

Alborno et al [1] analyze the role of government policy in the effort of countries to attract FDI. There has been a rapid increase in the level of FDI both greenfield and M&A, with the latter being more prominent. Essentially the paper analyses the effect of a subsidy for greenfield investment on the choice of entry mode and in particular the mode entry change from acquisition to greenfield FDI. A three country model is used, where two countries are members of a potential partnership in a preferential trade agreement and the third is 'a foreign country from outside the region', wishing to enter this through serving one of the two other countries. The potential willingness of the governments to provide measures that would affect the entry decision of the firm is examined in this analysis. Firstly the paper focuses on the case of intervention by only one of the two governments that may attract FDI, but in later sections the examination is turned to the analysis of the potential subsidy competition among the countries that compete to attract FDI. Depending on the level of the fixed cost for greenfield FDI, it is established that when this cost is low in value, a situation resembling a Prisoner's dilemma emerges. This implies that countries are better off without intervention, however they continue to provide policy measures. They also show that trade integration may increase harmful subsidy competition. Alborno et al [1] introduce the provision of lump sum subsidies by the government of the countries that

wish to attract MNEs, assuming that two countries will compete for Greenfield investment and examine the potential for subsidy competition depending on the Greenfield cost that the MNE will have to incur when entering a market. The analysis contrasts acquisition and Greenfield FDI as the two entry mode options. The welfare function of the country will define the optimal measure provided, as a result of the comparison between the welfare derived when one entry mode is chosen over another. The assumption is that subsidies will only be provided for Greenfield investment and thus the optimal measures prove to be functions of the Greenfield FDI cost, given by F . For the subsidy competition, a number of threshold values for the fixed cost F are derived, that assist in the analysis over the prevailing equilibria in the game. As the authors describe 'to be able to characterize the prevailing equilibrium for given social and private preferences over investment types, we must specify the amount of fixed costs incurred by a greenfield investor'. In an analysis that resembles the one in this chapter of my thesis the authors, using backward induction, derive the optimal subsidy measures the policy maker is willing to provide as functions of the fixed Greenfield costs and then rate the potential prevailing equilibria contingent to the fixed cost. Four equilibria are identified, two of which involve intervention in the form of Greenfield investment subsidisation, and two where no intervention takes place. In the latter cases, the governments do not intervene to affect the entry decision outcome, as they do not value Greenfield investment enough to incur the expenditure associated with it. Depending on the level of the fixed cost the following conclusions are reached; low fixed costs imply that subsidy competition leads to decreased welfare and 'subsidy expenditure is clearly a pure transfer of social surplus from the region to the multinational'. As the value

of F increases, acquisition proves to be the most profitable entry mode for the firm and thus the ability of the government to compensate for a switch of mode will be decreased. Even greater values of F lead to one of the two governments not finding it profitable to provide a subsidy and therefore only one country will intervene. When fixed costs exceed the highest threshold defined in the analysis, then the no intervention equilibrium prevails and therefore no subsidy competition takes place.

Qiu and Zhou [68] examine the incentives underlying international merger formation, based on gains from information sharing. Focusing on the case of informational asymmetry, they conclude that a 'merger in a Cournot oligopoly is more profitable if the merging firms have asymmetric information about market demand than if they have symmetric information'. They use however, only mergers as the potential entry mode in a market. This chapter of my thesis extends their analysis, aiming to examine the effect of the introduction of two more entry options, namely Greenfield investment and exporting on the entry mode choice of the multinational firm and the incentives of the host country government to influence this choice. The analysis of the Qiu and Zhou [68] paper is based on the concept that a local firm is better informed about the conditions in the local market, in comparison to a foreign firm. In the model analyzed, one foreign firm wishes to enter a market, where n domestic firms operate; these firms are fully informed of the demand conditions in the market and the foreign firm can only succeed in obtaining this information through a merger with one of the local firms. A two stage game is examined, with stage one consisting of the choice of one domestic firm and the foreign firm to merge and stage two describes the output setting decision in the market *à la* Cournot. When the choice of the merger takes place,

this can take the form of only information sharing or information sharing and output coordination. The former type of merger is profitable overall, and thus information sharing facilitates mergers, whereas in the latter case, the merger will only be profitable under a sufficiently differentiated product framework. When examining the effect of mergers on the welfare, non merging firm's profits and consumers surplus, the findings can be summarized in the following: sufficient product differentiation leads to the non-merging firm's profits reduction in the presence of a merger, however, total industry profits, consumers' surplus and social welfare are increased. In terms of anti-trust policies, 'when demand uncertainty is large and market competition is intense, international mergers should be encouraged because they are privately unprofitable but socially desirable. Under the opposite conditions, international mergers should be discouraged because firms have incentives to merge, but such mergers reduce social welfare'. My model uses the general framework that Qiu and Zhou [68] have introduced, in terms of formulating and treating demand uncertainty under a merger.

Research in the field of international entry modes can take various directions varying from empirical work examining parameters that influence the decision of firms to the analysis of intervention measures used by governments in order to attract greenfield investment or protect their market from any potential entry possibility. Some of these analyses are summarized in the following paragraphs.

A paper that treats cross border acquisitions not as perfect substitutes, which is the general consensus, but rather as imperfect substitutes is that of Nocke and Yeaple [64]. Firm characteristics are shown to differentiate the entry mode choice and therefore the two entry

mode options are not perfect substitutes. The level of the country's development defines the optimal entry mode, with acquisition being more prominent the higher the development of the country. In relation to the entering firm's efficiency, the higher the cost advantage of the entering firm the higher the probability of greenfield investment be chosen as the optimal entry mode. In their analysis, Nocke and Yeaple [64] propose the examination of policy implications, for example any potential restrictions on M&As, which bring 'less' to the host country compared to greenfield FDI. The latter leads to the creation of a new establishment, whereas the cross-border acquisition simply involves a change of ownership of local production. This chapter of my thesis aims to explore this suggestion, in examining the possible incentivisation techniques the policy maker can adopt in an effort to affect the entry mode choice of the foreign firm, should this be different than the host country preferred option, in terms of welfare maximization.

Empirics and parameters

A number of parameters influences the entry decision, such as the size of the market. When greenfield FDI and acquisitions are treated as the only two potential entry modes, Ferrett [32], [33] has shown that the size of the market is indeed a crucial factor for the entry mode choice. Ferrett [32] analyses the decision of firms to engage in greenfield FDI or an acquisition, when R&D can influence the production cost of the rival firm and concludes that in medium size markets, acquisition (or brownfield) FDI will be the dominant choice of entry mode, whereas in large markets, greenfield FDI will prevail as the entry mode when the sunk cost associated with the set up of a new plant is not too large. If the entering firm was using exporting to serve the market, then in a segmented markets model, the increase

in the transport cost/ tariff associated with exports creates additional incentives for tariff jumping FDI. Similarly, in Ferrett [33], entry deterrence via greenfield FDI in 'intermediate sized' markets is examined. For greenfield investment to arise, two conditions must be met: (1) the entry markets must be sufficiently large and (2) sufficiently small plant costs must exist. Relative to the greenfield FDI, acquisition FDI is a soft response by incumbents to the entry threat: 'in intermediate sized markets acquisition FDI provokes, but greenfield FDI deters, entry' (page 15).

The level of growth of the market the firms wish to enter can also be included as a definitive factor in the choice of the mode. Calderon et al [10] in their empirical paper, show that the growth of a country can be a factor that attracts FDI in general, when it proceeds M&As and Greenfield investment. In industrialized countries greenfield FDI can lead to domestic investment, which in turn can result to cross-border mergers. The model also shows that an increase in the M&As can be followed by greenfield investment, so the M&A boom can be succeeded by more investment decisions. The same results are derived even with a different database consisting of a smaller number of industrialized countries and a smaller number of developing countries in Calderon et al [11].

Entry modes options

The aim of this chapter of my thesis is to add to the literature a comparison between three potential entry mode options. So far few models directly compare exports, acquisitions and greenfield FDI. Rather one of the three options is treated as exogenous and the two remaining options are contrasted for the derivation of the optimal entry strategy. One example of a deviation from this norm is the paper by Buckley and Casson [9] in which

they endeavour the comparison of all potential modes of entry, ranging from acquisition and greenfield FDI to subcontracting and franchising. This comparison includes all variables that are considered to play a role in defining the entry mode choice of a firm, such as location costs and the country's market structure. The concluding remarks made by the authors show that as expected, transport cost increases make the choice of production in the host market more favourable, and that the market structure is crucial for the entry mode decision; local capacity increases and competition is strengthened when greenfield investment is chosen, whereas entry through acquisition does not affect the number of firms operating in the market, and thus does not have an impact on competition per se. This result provides an explanation for the incentives that the host country government offers to attract greenfield FDI and/or restrict access to the market through acquisitions. Tax incentives may be provided and the policy maker may bargain over subsidization with the potential entrant, in exchange for commitments for increases in the local value added, described also as 'job creation'. My model specifically examines the incentives which the policy maker may employ to enable this influencing move.

When only acquisition and greenfield investment are considered, for entry in a market where a cost asymmetric duopoly operates the actual production cost level will define the optimal firm decision, as shown by Gorg [37]. In more detail, the three options for the entrant can be described as: (1) acquisition of the low cost firm, (2) acquisition of the high cost firm and (3) entering through greenfield investment. A significant difference in the cost differential between the low cost firm and the two remaining firms, the high cost firm and the foreign entrant, will imply that the optimal choice is greenfield investment.

Overall, however, the acquisition of the low cost firm may be the preferred entry mode for intermediate cost differentials. Also, when the the host country welfare is examined, the conclusion reached is that because of increased competition of a firm entering through greenfield FDI, welfare is maximum as a result of the positive effect of competition on consumer's surplus.

Policy instruments to affect entry modes

Matoo, Olarreaga and Saggi [56] examine the potential use of policy measures to influence the entry mode choice of a foreign firm, when considering the gains from technology transfers associated with FDI. In a similar framework to the one adopted in the analysis of this chapter of my thesis, they show that if the entry mode chosen by the firm is not consistent with the preference of the government, then the adoption of policy restrictions can influence the optimal choice of firms. For a high cost technology transfer, the government prefers acquisition, whereas the firm would prefer direct entry, so restricting direct entry would increase welfare for the domestic country. When the cost of transferring technology for the entering firm is high, then it prefers entry through acquisition, whereas the policy maker has a preference for direct entry. This is due to the fact that such a move increases competition and also implies a greater technology transfer on the foreign firm's part since the creation of a stronger 'strategic' position in the market incentivises the firm to do so. Governments may have incentives to restrict different modes of foreign firm entry depending on the industry type.

When examining the literature associated with protectionist measures used and their effect on entry mode choices, it is observed that the establishment of a production plant in

the market served by the MNE, as a means of avoiding the protectionist measures set by the host country, is one of the oldest and most common strategies used by firms and the most common explanation of the choice of FDI. Blonigen and Fenstra [6] suggest two theories associated with FDI and its connection to its use as a tactic to avoid protectionist measures; one is the theory of protection induced FDI, where the threat of protection increases non-acquisition FDI, but does not affect acquisitions. The second is the theory of tariff jumping, where 'once protectionist measures are erected to foreign imports, foreign firms invest in the protectionist country to get beyond the tariff wall'.

Guisinger and Associates [39] suggest the use of tax and other incentives to attract MNEs or influence their strategic decisions. In our analysis, the extent of the effect of these incentivisation techniques in the market entry strategic decisions of a firm is examined. There is particular focus on the potential switch of entry mode as a result of the provision of these measures.

Government policy measures are also proposed as incentivisation mechanisms in Chor [15] where subsidies are used as tools to achieve welfare maximization in the host/importing country. The model suggests the existence of consumption gains associated with the relocation of production by the MNE to the country it was originally serving through exports, as prices are lowered as a result of savings on cross border transaction costs. A host government has therefore an incentive to subsidize FDI, as this move will attract the most efficient of the foreign firms, thus resulting to welfare improvements.

The lobbying effort expended by domestic firms in an effort to achieve protection against the entry of foreign firms through greenfield investment is examined in Ellingsen

and Warneryd [30]. Domestic firms lobby for decreased protectionist measures imposed on imports from foreign firms, in order to reduce the incentives of the foreign MNE to enter the market through FDI as a tariff jumping strategy. Such a move, however, can be viewed as a 'subsidy' towards imports. Although the case of protection through direct measures such as FDI is not examined, as it is more difficult to erect barriers to investment, the analysis of this chapter of my thesis, extends the above analysis to include such measures.

The same entry mode options as in my model are examined by Bjorvatn [5]. In this analysis, the firm can choose to enter the market through exports, incurring a cost t , through greenfield investment at a cost F or acquisition, paying an acquisition price. It is shown that a merger may prove to be profitable, only in the case where entry costs are high. Economic integration can affect cross border merger profitability through the potential change in the entry mode of rivals; for example, if the cost associated with exports is reduced then rival may opt for an acquisition. A change in the entry mode from greenfield to exports reduces the competitive pressure on the merged firm and thus mergers are more profitable. Also, the profitability of the alternative to a merger entry modes will also be affected by economic integration.

Eicher and Kang [29] also focus their analysis on the above mentioned entry modes. In their paper, the optimal mode of entry is defined by the level of competition in the market where the MNE aims to export to, acquire a firm or set its own subsidiary in. For high competition levels the only firm that is able to survive is the lowest cost one, which will be the MNE if it enters through greenfield FDI or exports. For intermediate competition levels the actual amount of the greenfield cost and tariffs will define whether the local firm can

be driven out of the market. Lastly, in the case of weak competition levels, both firms may remain in the market.

Mueller [59] shows that the cost of greenfield investment makes acquisition more attractive if it is high, but when it exceeds a threshold level, then it makes entry in general unappealing. If the domestic and foreign firms are characterized by the same technologies, then acquisition is the preferred entry mode, as it leads to low profit levels for the entrant. Greenfield is preferred if the market is competitive, if the greenfield cost is low and if the firms are operating under different technologies. Alternative, if the greenfield cost is high and reaches the level above which no entry is preferred, if the technologies for the two firms are similar and if there is intermediate competition in the market, then greenfield investment is not preferred.

Lastly, in Raff et al [69] the profitability of greenfield investment affects the choice between a joint venture and a merger, as it determines the outside option of the potential acquisition target or joint venture partner. The multinational prefers a merger to greenfield investment if the fixed cost of greenfield investment is sufficiently large. If greenfield investment is less profitable than exporting, local firms may refuse to participate in a joint venture, leaving the multinational to choose between M&A and exporting. The acquisition price in the case of a merger is larger than exporting than with a credible greenfield investment threat. The profitability of greenfield investment relative to exporting determines the outside options for local firms and hence their decision of whether to accept a merger or a joint venture offer. If greenfield investment is more profitable than exporting, the price the MNE has to offer to acquire a local firm is reduced so an M&A may be preferred to green-

field. If the MNE prefers exporting to greenfield investment, a local firm may not accept a joint venture and the MNE will choose M&A if the trade cost is sufficiently large.

3.3 Assumptions and Model Set Up

The aim of the analysis as mentioned above is the examination of the host country policy maker's incentives to provide measures to influence the entry mode chosen by a foreign firm, wishing to enter the market. A number of simplifying assumptions are made at this point to assist the analysis.

The world is assumed to consist of two countries, the foreign denoted by F and the host H . The host country contains, and its market is already served by its n locally owned domestic firms. The foreign country contains a number of firms; the model analyzed below, aims to analyze the entry decision of one of these foreign firms, and so for the purposes of this analysis the foreign entrant is considered to be a monopolist, without loss of generality. Therefore attention is focused on the host market which can be seen as served by n domestic firms and the potential entrant, the foreign monopolist. Cost symmetry is assumed in the host market, where firms produce with a constant marginal cost c . The foreign firm is assumed to have a lower marginal cost, than the other host country firms, here taking the value of zero ($c_F = 0$) and can transfer this cost advantage to any plant it chooses to acquire or build in the host market. This lower marginal cost for the potential MNE can be attributed, as Horstmann and Markusen suggest [47], to the existence of firm-specific assets closely related to the concept of ownership advantage.

The model will be considered as a three stage game. In stage 1, the government provides lump sum subsidies, in order to maximize its welfare, when the optimal choice of the firm differs from the optimal government choice. The setting of these measures is done through the comparison of the welfare in the case where the government entry option is chosen and the case where the firm chooses its optimal mode in the absence of any intervention. The government is willing to provide a policy measure up to the point where it becomes indifferent to the option chosen.

In the second stage, the foreign firm chooses how to supply the host country market. Assessing the policy measure it would be receiving from the foreign government to induce it to a mode switch, the firm establishes whether it would optimize its choice by entering the market according to the wishes of the government. The options it faces include exporting, which would imply production in its own country, and incurring a transport cost t , Greenfield investment, which requires the set up of a new plant in the host country at a cost G . This is randomly set by nature and takes values from interval $[0, \bar{G}]$. This analysis aims to focus on the incentivisation mechanisms provided by the government wishing to alter the entry mode option of the firm, when this option is not welfare enhancing. Therefore we will not concentrate on situations when the firm will not wish to enter the market. As this is the case, the simplifying assumption is made, that there exists a \bar{G} above which the firm does not find profitable to enter the market and for later use $\bar{G} < \check{G} < \hat{G} < \tilde{G}$, where \check{G} and \hat{G} the threshold values for no entry choice of the firm for the asymmetric and symmetric cases respectively. Thus the analysis will focus on the interval $[0, \bar{G}]$. Finally, the third option would be the acquisition of an existing domestically owned firm in the host

market, paying an acquisition price denoted by V . The firm also considers the option of not entering the host market.

In stage three, all the firms serving the market make their optimal production decision, under Cournot competition. The number of serving firms will equal $n + 1$, if the foreign firm enters the market either through exporting or greenfield investment, however should an acquisition be chosen as the optimal mode, then the number of firms equals n .

As Alborno et al [1] suggest, the use of lump sum policy measures (set in stage 1) ensures that there is no distortion in the setting of the optimal production level set in stage 3, given the choice of the entry mode. However, the entry mode decision stage (stage 2) where the firm assesses its potential profits from using any of the options is affected, as policy measures are set in order to influence this decision in a favourable to the policy maker outcome. The equilibrium outcome will be derived through the use of backward induction.

Note that for the foreign firm, when it chooses to enter the market through exporting, its cost function contains the production cost plus the transport cost. As, however, by assumption the production cost is zero, the cost function equals the transport cost only: $c_F = 0 + t = t$.

The host country government may choose to create switch mode incentives for the entering firm, through the use of subsidization measures, when the optimal foreign firm entry mode does not match the preferable host firm entry mode. Thus, the government provides a subsidy denoted by S , as a reward for choosing the governments optimal choice or a tax T as a punishment away from the undesired outcome.

Demand in the host market is given by

$$P = a + \theta - \sum_{i=1}^n Q_{Hi}^{mj} - Q_F^{mj} \quad (3.1)$$

where $j \in [e, g, acq]$ denotes exports, greenfield FDI and acquisition respectively and $m \in [S, A]$ stands for Symmetry and Asymmetry accordingly. Parameter θ denotes a random variable with mean $E(\theta) = 0$ and variance $Var(\theta) = \sigma^2$. The inclusion of this parameter captures the potential informational asymmetry which is examined in section 3.5 and thus is required to facilitate the comparison of the outcomes under symmetric and asymmetric information. Parameter a in this framework can be interpreted as a measure of the country size¹⁸.

In terms of notation, if the firm is exporting to the host country, then the host country is the importer of the product; therefore in the following analysis the terms exporting and importing will be used interchangeably to describe the same procedure: the entry of the foreign firm in the host market through exporting.

Subscript F denotes foreign, Hi refers to the individual domestic firm in the host market and HT denotes functions referring to the host market in terms of production as a whole. Superscripts acq, e, g denote the three entry modes examined here namely acquisition, exporting and greenfield investment; superscript ne denotes no entry.

Firstly the analysis focuses on the symmetric information case, where both the foreign and the domestic firms have full information of the demand in the market, and thus have knowledge of parameter θ . Then, the analysis is turned to the asymmetric situation, where the domestic firms only have knowledge of θ .

¹⁸ This is also used in Alborno et al [1] as an assumption in the description of the country's market demand.

3.4 Symmetric Information Case

3.4.1 Profit Analysis

Exports

When the entry mode chosen is exporting, then the foreign firm has to incur a transportation cost. The foreign firm chooses its production level through the maximization of its profit function:

$$\Pi_F^{Se} = PQ_F^{Se} - (0 + t)Q_F^{Se} \quad (3.2)$$

On their part each of the n domestic firms in the host country seeks to maximize their respective profit function:

$$\Pi_{Hi}^{Se} = PQ_{Hi}^{Se} - cQ_{Hi}^{Se} \quad (3.3)$$

where $i = 1, 2, \dots, n$

The first order conditions lead to the following output and price levels; the foreign firm output equals:

$$Q_F^{Se} = \frac{(a + \theta - (n + 1)t + nc)}{n + 2} \quad (3.4)$$

The individual and total host country firm production levels, denoted by subscripts Hi and HT respectively, are given by:

$$Q_{Hi}^{Se} = \frac{(a + \theta - 2c + t)}{n + 2} \quad (3.5)$$

$$Q_{HT}^{Se} = nQ_{Hi}^{Se} = n \frac{(a + \theta - 2c + t)}{n + 2} \quad (3.6)$$

Therefore the total output in the host market is given by the sum of the foreign firm exports plus the host firm domestic production:

$$Q_T^{Se} = \frac{(n+1)(a+\theta) - nc - t}{n+2} \quad (3.7)$$

The price and profit levels are in turn defined as:

$$P = \frac{a + \theta + nc + t}{n+2} \quad (3.8)$$

$$\Pi_F^{Se} = \frac{[a + \theta - (n+1)t + nc]^2}{(n+2)^2} \quad (3.9)$$

$$\Pi_{Hi}^{Se} = \frac{(a + \theta - 2c + t)^2}{(n+2)^2} \quad (3.10)$$

and

$$\Pi_{HT}^{Se} = n \frac{(a + \theta - 2c + t)^2}{(n+2)^2} \quad (3.11)$$

Greenfield Investment

If the foreign firm chooses to enter the host market through greenfield investment, by setting its own subsidiary, then it must incur a fixed setting up cost G .

The foreign firm, by producing locally, maximizes its profit function that no longer incorporates a transport cost; it does however contain the cost for greenfield investment:

$$\Pi_F^{Sg} = PQ_F^{Sg} - G \quad (3.12)$$

The representative local firm maximizes profits:

$$\Pi_{Hi}^{Sg} = PQ_{Hi}^{Sg} - cQ_{Hi}^g \quad (3.13)$$

The output levels are given by:

$$Q_F^{Sg} = \frac{(a + \theta + nc)}{n + 2} \quad (3.14)$$

$$Q_{Hi}^{Sg} = \frac{(a + \theta - 2c)}{n + 2} \quad (3.15)$$

$$Q_{HT}^{Sg} = nQ_{Hi}^{Sg} = n \frac{(a + \theta - 2c)}{n + 2} \quad (3.16)$$

Therefore the total output in the host market is given by the sum of the foreign firm exports plus the host firm domestic production:

$$Q_T^{Sg} = \frac{(n + 1)(a + \theta) - nc}{n + 2} \quad (3.17)$$

The price and profit levels are in turn defined as:

$$P = \frac{a + \theta + nc}{n + 2} \quad (3.18)$$

$$\Pi_F^{Sg} = \frac{[a + \theta + nc]^2}{(n + 2)^2} - G \quad (3.19)$$

$$\Pi_{Hi}^{Sg} = \frac{(a + \theta - 2c)^2}{(n + 2)^2} \quad (3.20)$$

and

$$\Pi_{HT}^{Sg} = n \frac{(a + \theta - 2c)^2}{(n + 2)^2} \quad (3.21)$$

The main observation to be made at this point is that the profits for the representative local firm are greater in the case of exports because of the 'Protectionism' effect of the transportation cost incurred by the exporting foreign firm.

Acquisition

For the last entry option examined here, the foreign firm may decide to acquire one of the local firms, and thus the number of the market serving firms will remain equal to n . The foreign firm in this case has to pay the local firm an acquisition price, which is given by the weighted sum of the profits that the firm would earn should the foreign firm enter the market by choosing any of the other options: exporting or greenfield FDI. The following paragraphs and appendix C.1 provide more insight on the derivation of the acquisition price.

The foreign firm maximizes its profits, comprising of the revenue from its host market sales minus the cost of purchasing the already existing domestic plant.

$$\Pi_F^{Sacq} = PQ_F^{Sacq} - V \quad (3.22)$$

where V denotes the acquisition price paid by the foreign firm.

The representative of the remaining $n - 1$ locally owned firms set their output through the maximization of their profits function:

$$\Pi_{Hi}^{Sacq} = PQ_{Hi}^{Sacq} - cQ_{Hi}^{Sacq} \quad (3.23)$$

The first order conditions define the following output levels for the foreign and representative domestic firm:

$$Q_F^{Sacq} = \frac{a + \theta + (n - 1)c}{n + 1} \quad (3.24)$$

$$Q_{Hi}^{acq} = \frac{a + \theta - 2c}{n + 1} \quad (3.25)$$

Similarly, the total output by the domestically owned firms and the total output in the host market are given by:

$$Q_{HT}^{Sacq} = (n-1) \frac{a + \theta - 2c}{n+1} \quad (3.26)$$

and

$$Q_T^{Sacq} = \frac{na + n\theta - (n-1)c}{n+1} \quad (3.27)$$

The price level is given by:

$$P = \frac{a + \theta + (n-1)c}{n+1} \quad (3.28)$$

Acquisition price

It is essential at this point to establish the acquisition price to be paid by the foreign firm. It has already been briefly mentioned that this will equal the sum of the representative firm's profits when either of the two other entry options is chosen. The supporting argument for this setting is the fact that there is a requirement for incentivisation of the local firm being acquired. If the firm is aware that the profits of the disagreement points (outside options/next best alternatives) can be either profits from the entry through Greenfield FDI or entry through exports by the foreign firm, then it will settle for no less. We follow Albornoz et al [1], on this, augmenting the acquisition function they use to include the sum of profits in the two entry cases, instead of profits in the case of entry or no entry. Essentially in the previously mentioned analysis, the only alternative entry mode is greenfield FDI and thus the acquisition price was given by the weighted sum of profits in the case of entry or no entry. Appendix C.1 also includes a brief description of the acquisition price setting, complementary to the one below.

Here the acquisition price is given by the following function:

$$\begin{aligned} V &= \beta \Pi_{Hi}^{Sg} + (1 - \beta) \Pi_{Hi}^{Se} \\ &= \beta \frac{(a + \theta - 2c)^2}{(n + 2)^2} + (1 - \beta) \frac{(a + \theta - 2c + t)^2}{(n + 2)^2} \end{aligned} \quad (3.29)$$

The above expression shows that the profits in the case of foreign firm exports are higher for the domestic firm in comparison to the case of greenfield FDI; this is attributed to the fact that the transport cost prevents the foreign firm from higher exports, leaving the local firms serving the market with greater output level compared to the case where no transport costs are incurred.

Essentially, the highest acquisition price the domestic firm could potentially receive equals profits in the case of entry through exports and the lowest, when the entry mode chosen is greenfield FDI. The profitability of the greenfield FDI as an outside option compared to exports as the alternative mode, clearly depends on the level of the greenfield cost, thus the probability of this set up cost being high or low provides the foreign firm a level of bargaining power. This bargaining power is given by parameter β . The foreign firm wishing to enter the host market will be in a position to pay the lower acquisition price if the greenfield investment cost is low, as this would be the optimal outside option. Alternatively, a higher acquisition price will have to be paid, in the form of the export profits, when the greenfield cost is high, implying that the firm will opt for exports as the outside option and the foreign firm has lower bargaining power. Note here that this analysis does not focus on bargaining theory, but uses some of its principles, to provide a clearer investigation of this take-it-or leave it offer towards the chosen locally owned domestic firm.

Examining the two extreme cases, if the foreign firm has full bargaining power ($\beta = 1$) and so the greenfield cost is low, then the acquisition price equals the domestic firm profits in the case of greenfield,

$$V = \frac{(a + \theta - 2c)^2}{(n + 2)^2} \quad (3.30)$$

If on the other hand the bargaining power is low ($\beta = 0$) implying that the greenfield cost is high, then the acquisition price is equal to the profits of the domestic firm in the case of export,

$$V = \frac{(a + \theta - 2c + t)^2}{(n + 2)^2} \quad (3.31)$$

The use of the above two expressions allows the definition of the profits for the foreign and domestic firms respectively.

Using the above general expression for the acquisition price, we can define the profits for the foreign and domestic firms respectively;

$$\Pi_F^{Sacq} = \frac{[a + \theta + (n - 1)c]^2}{(n + 1)^2} - \left[\beta \frac{(a + \theta - 2c)^2}{(n + 2)^2} + (1 - \beta) \frac{(a + \theta - 2c + t)^2}{(n + 2)^2} \right] \quad (3.32)$$

$$\Pi_{Hi}^{Sacq} = \frac{(a + \theta - 2c)^2}{(n + 1)^2} \quad (3.33)$$

Therefore

$$\Pi_{HT}^{Sa} = (n - 1) \frac{(a + \theta - 2c)^2}{(n + 1)^2} \quad (3.34)$$

It should be noted at this point that if the government does not intervene in the market then for the foreign firm to prefer Greenfield to an acquisition, the expectation of the difference between the profit levels derived in each of the two situations must be positive.

Therefore, the following must hold:

$$E(\Pi_F^{Sg} - \Pi_F^{Sacq}) > 0 \Rightarrow$$

$$G < \frac{(a + nc)^2}{(n + 2)^2} - \frac{(a + (n - 1)c)^2}{(n + 1)^2} + \beta \frac{(a - 2c)^2}{(n + 2)^2} + (1 - \beta) \frac{(a - 2c + t)^2}{(n + 2)^2} + \frac{(n^2 - 2)\sigma^2}{(n + 1)^2(n + 2)^2} \quad (3.35)$$

The main observation to be made at this point is that the first two terms of the expression, giving the difference in the revenue if Greenfield is chosen over the acquisition scheme, is negative. The other two terms as already mentioned denote the acquisition price which will depend on the foreign firm's bargaining power.

So, the threshold values of the cost, above which acquisition will be preferred to greenfield FDI, will be greater if the greenfield cost is high ($\beta = 0$), since then the acquisition price is greater. This value will, alternatively, be lower if the cost of greenfield investment is low, leading to the prevailing of FDI rather than exports as the entry mode ($\beta = 1$).

Threshold values

As mentioned in the previous section, the greenfield cost level will define the threshold values for the sunk cost that the firm will be willing to forgo in order to enter the host country market. There is need for the establishment of cut off prices for the choice between the entry options with respect to the firm profits. If the cost for the establishment of the subsidiary is low, then the foreign firm will choose to enter the host country's market through greenfield FDI rather than acquisition of an already existing plant, as the profits

would be greater. Exports would lead to the lowest level of profits. However, cases can be identified, where the option of exporting leads to greater profits for the firm.¹⁹ The choice between greenfield investment and the other two potential options is based on the level of G , with greenfield investment preferred to the other options if the expected profits for this are greater compared to profits of the other option. Therefore the cut off values are given by:

Proposition 16 *Suppose there exists information symmetry among all firms (all firms have access to the same information). Then for all values of a, c, n, t :*

(1) *There exists a unique greenfield investment cost $G' \in [0, \bar{G}]$, such that iff $G < G'$ greenfield investment is strictly preferable to acquisition and iff $G > G'$, the option of acquisition is preferred.*

(2) *There exists a unique greenfield investment cost $G'' \in [0, \bar{G}]$, such that for $G < G''$ greenfield investment is strictly preferable to exports and iff $G > G''$, the exporting option is strictly preferred.*

Proof. In Appendix C.2 ■

The above proposition implies that greenfield investment is preferable if the greenfield investment cost does not exceed the threshold values. No entry yields no profits for the foreign firm, therefore the firm does not wish to enter the market when facing entry through greenfield investment if the expected profits from entering are negative. Therefore

¹⁹ For example, when both the tax t and the production cost c are set equal to zero, the difference between the profits levels takes the form:

$$\Pi_F^e - \Pi_F^{acq} = 2(n+1)^2(a+\theta)^2 - (n+2)^2(a+\theta)^2$$

This expression is positive for any value of n which is assumed to be greater than 1.

the firm does not enter the market if $G > \frac{(a+nc)^2}{(n+2)^2} + \frac{\sigma^2}{(n+2)^2} \Rightarrow G > \hat{G}$. Note that for the purposes of the following analysis this is assumed to be greater than \bar{G} .

3.4.2 Welfare Analysis

The above analysis included the examination of the optimal entry choice by the foreign MNE. Now we turn to the investigation of the incentives of the host country government to intervene in the market, in order to affect this entry mode choice by the foreign firm, through the setting of policy measures. When the entry mode choice of the firm does not coincide with the choice of the government regarding the entry of the MNE, as defined by the welfare level attained in each possible entry decision, the policy maker may wish to provide incentivisation measures that would enable the firm to switch its optimal mode. The gain for the host government will be realised through the additional welfare from inducing the entry mode switch of the entering firm minus the cost of the policy measure.

Turning to the decision of the government concerning which entry mode would increase welfare in the host country, we need to define the policy maker's objective function. The welfare function for all the three entry choices examined comprises of the total profits of the locally owned firms denoted by Π_{HT}^i and consumers' welfare, denoted by CS_{HT}^i ²⁰.

²⁰ The linear demand function used implies that Consumers' surplus is given by:

$$CS_{HT}^i = \frac{(P^{\max} - P)Q^i}{2}$$

The demand function is given by: $P = a + \theta - \sum_{i=1}^n Q_{Hi}^j - Q_F^j$ and so $P^{\max} = a + \theta$.

Thus

$$CS_{HT}^i = \frac{(Q^i)^2}{2}$$

As this analysis focuses on the host country incentives to affect the decision of the entering firm, only the welfare from the host country is investigated.

The functions for welfare in the situations examined are given by:

$$W^{Se} = \Pi_{HT}^{Se} + CS^{Se} \quad (3.36)$$

$$W^{Sg} = \Pi_{HT}^{Sg} + CS^{Sg} + G \quad (3.37)$$

$$W^{Sacq} = \Pi_{HT}^{Sacq} + CS^{Sacq} + V \quad (3.38)$$

$$W^{Sne} = \Pi_{HT}^{Sne} + CS^{Sne} \quad (3.39)$$

When examining entry through greenfield investment, the welfare function also entails the cost the foreign firm has to forgo in order to set its subsidiary in the host country. This cost can be perceived as the charge for building a new plant. In the case of acquisition, the number of locally owned firms decreases and thus total profits included in the welfare function also decrease, however, the acquired firm receives an acquisition price which is included in the objective function instead. Note that the welfare function, when the foreign firm enters through exporting does not include the transport cost, as this is assumed not to be a tariff.

In more specific terms the welfare functions are defined as:

$$W^{Se} = \frac{2n(a + \theta - 2c + t)^2 + [(n + 1)(a + \theta) - nc - t]^2}{2(n + 2)^2} + \frac{(n + 2)t(a + \theta - (n + 1)t + nc)}{2(n + 2)^2} \quad (3.40)$$

$$W^{Sg} = \frac{2n(a + \theta - 2c)^2 + [(n + 1)(a + \theta) - nc]^2}{2(n + 2)^2} + G \quad (3.41)$$

$$W^{Sacq} = \frac{2(n - 1)(a + \theta - 2c)^2 + [n(a + \theta) - (n - 1)c]^2}{2(n + 1)^2} + \beta \frac{(a + \theta - 2c)^2}{(n + 2)^2} + (1 - \beta) \frac{(a + \theta - 2c + t)^2}{(n + 2)^2} \quad (3.42)$$

When the firm chooses not to enter the market the welfare function is given by:

$$W^{Sne} = \frac{2n(a + \theta - c)^2 + n^2(a + \theta - 2c)^2}{2(n + 1)^2} + G \quad (3.43)$$

The welfare level obtained in the case of entry through greenfield investment depends mainly on the greenfield cost level. Therefore, in a similar manner as in the firm mode choice, the decision between greenfield investment and the other two potential options is based on the level of G , with greenfield investment preferred to the other options if the expected welfare levels obtained from this mode are greater than the level of the other option. Hence, corresponding to Proposition 16 which examined the firm perspective, Proposition 17 provides the threshold values for G , from the welfare angle.

Proposition 17 *For all values of a, c, n, t :*

(1) *There exists a unique greenfield investment cost $G^* \in [0, \bar{G}]$, such that iff $G > G^*$ greenfield investment is strictly preferable to entry through exports and iff $G < G^*$, the option of exports is strictly preferred.*

(2) *There exists a unique greenfield investment cost $G^{**} \in [0, \bar{G}]$, such that iff $G > G^{**}$ greenfield investment is strictly preferable to an acquisition and iff $G < G^{**}$, the acquisition option is strictly preferred.*

(3) *The government will prefer the foreign firm not to enter the market when its entry option is greenfield investment, if $G < G^{***}$.*

Proof. In Appendix C.3 ■

3.5 Asymmetric Information Case

The analysis in the previous section is based on the assumption that all firms, both the domestic and the foreign firm, have access to the same information. As suggested by Qiu and Zhou [68] 'a firm often has better information about the local market than about foreign markets'. Thus the locally owned domestic firms are more likely to have 'insider' information about the market than the foreign firm wishing to enter it. In particular, the following analysis will examine the situation where one element of the demand function is unknown to the foreign firm, and this information can only be obtained if the firm acquires one of the domestic firms, which has full information access.

Therefore, the domestic firms have full information, and realize the level of parameter θ . Hence each of the n identical domestic firms faces demand given by: $P_{Hi}^{A(in)} = a + \theta - Q_{Hi}^i - Q_{H(-i)}^i - Q_F^i$, where $Q_{H(-i)}^i$ denotes the output of the $n - 1$ remaining locally owned firms. Therefore the demand faced by all firms in the host market is equal to $P^{A(in)} = a + \theta - Q_{HT}^i - Q_F^i$. The foreign firm on the other hand is not certain of the demand level in the market and thus forms expectations over it. Hence the foreign firm perceives the demand to be given by:

$$P_F^{A(u)} = E(P^{A(in)}) = E(a + \theta - Q_{HT}^i - Q_F^i) = a - Q_{HT}^i - Q_F^i \quad (3.44)$$

Note that superscripts $A(in)$ and $A(u)$ denote informed and uninformed respectively, in the case of Asymmetric information.

In the next section we turn the analysis to the output produced and profits realized by the firm when each of the entry modes is chosen respectively.

3.5.1 Profit Analysis

Exports

As in the case of entry through exports under symmetric information, the foreign firm has to incur a transportation cost t . The firm, based on its expectations over the demand level in the host market, sets output through the maximization of its profits.

$$\Pi_F^{A(u)e} = P_F^{A(u)} Q_F^{A(u)e} - t Q_F^{A(u)e} \quad (3.45)$$

The representative domestic firm maximises the following profits function containing the known demand:

$$\Pi_{Hi}^{A(in)e} = P^{A(in)} Q_{Hi}^{A(in)e} - c Q_{Hi}^{A(in)e} \quad (3.46)$$

Setting the FOCs²¹ equal to zero and solving the system of equations derived leads to the setting of the following output levels:

$$Q_F^{A(u)e} = \frac{a - (n+1)t + nc}{n+2} \quad (3.47)$$

The domestic firms accordingly set their optimal production levels, using the knowledge of the actual demand. Thus substituting in the response function derived from the FOC the output for each individual domestically owned firm equals:

$$Q_{Hi}^{A(in)e} = \frac{a + t - 2c}{n+2} + \frac{\theta}{n+1} \quad (3.48)$$

Therefore the output of all the domestically owned firms equals

$$Q_{HT}^{A(in)e} = n \left[\frac{a + t - 2c}{n+2} + \frac{\theta}{n+1} \right] \quad (3.49)$$

and the total production by all the $n+1$ operating firms is given

$$Q_T^{Ae} = \frac{(n+1)a - t - nc}{n+2} + \frac{n\theta}{n+1} \quad (3.50)$$

Consequently the profits realized by the operating are given by the following expressions:

$$\Pi_F^{A(u)e} = [P^{A(in)} - t]Q_F^{A(u)e} = \left[\frac{a - (n+1)t + nc}{n+2} \right]^2 + \frac{\theta}{n+1} \left[\frac{a - (n+1)t + nc}{n+2} \right] \quad (3.51)$$

²¹ Note that for the foreign firm the first order condition equals:

$$\begin{aligned} \frac{d\Pi_F^{A(u)e}}{dQ_F^{A(u)e}} &= \frac{dE(P^{A(in)})}{dQ_F^{A(u)e}} Q_F^{A(u)e} + E(P^{A(in)}) - t = 0 \\ &\Rightarrow \\ Q_F^{A(u)e} &= \frac{a - E(Q_{HT}^{A(in)e}) - t}{2} \end{aligned}$$

The expected level of production as perceived by the foreign firm equals:

$$E(Q_{HT}^{A(in)e}) = n \left[\frac{a - c - Q_F^{A(u)e}}{n+1} \right] = Q_{HT}^{A(u)e}$$

$$\Pi_{Hi}^{A(in)e} = [P^{A(in)} - c]Q_{Hi}^{A(in)e} = \left[\frac{a + t - 2c}{n + 2} + \frac{\theta}{n + 1} \right]^2 \quad (3.52)$$

$$\Pi_{HT}^{A(in)e} = [P^{A(in)} - c]Q_{HT}^{A(in)e} = n \left[\frac{a + t - 2c}{n + 2} + \frac{\theta}{n + 1} \right]^2 \quad (3.53)$$

Greenfield Investment

When the foreign firm enters through greenfield investment it forgoes a cost G . It maximizes its profits function:

$$\Pi_F^{A(u)g} = P_F^{A(u)}Q_F^{A(u)g} - G \quad (3.54)$$

The output set by the firm equals

$$Q_F^{A(u)g} = \frac{a + nc}{n + 2} \quad (3.55)$$

Given the actual demand level, the domestic firms in turn set their output at

$$Q_{Hi}^{A(in)g} = \frac{a - 2c}{n + 2} + \frac{\theta}{n + 1} \quad (3.56)$$

Total production by the locally owned firms and the total output in the market respectively equal

$$Q_{HT}^{A(in)g} = n \left[\frac{a - 2c}{n + 2} + \frac{\theta}{n + 1} \right] \quad (3.57)$$

$$Q_T^{Ag} = \frac{(n + 1)a - nc}{n + 2} + \frac{n\theta}{n + 1} \quad (3.58)$$

The profits levels received by the foreign firm and the representative firm are given by the following expressions

$$\Pi_F^{A(u)g} = [P^{A(in)}]Q_F^{A(u)g} - G = \left[\frac{a + nc}{n + 2} \right]^2 + \frac{\theta}{n + 1} \left[\frac{a + nc}{n + 2} \right] - G \quad (3.59)$$

$$\Pi_{Hi}^{A(in)g} = [P^{A(in)} - c]Q_{Hi}^{A(in)g} = \left[\frac{a - 2c}{n + 2} + \frac{\theta}{n + 1}\right]^2 \quad (3.60)$$

In aggregate the profits for the n locally owned firms equal:

$$\Pi_{HT}^{A(in)g} = [P^{A(in)} - c]Q_{HT}^{A(in)g} = n\left[\frac{a - 2c}{n + 2} + \frac{\theta}{n + 1}\right]^2 \quad (3.61)$$

Acquisition

The entry of the foreign firm through an acquisition, implies that the firm has access to full information, and therefore acquires the necessary ‘insider’ information to eliminate any misconception regarding the demand level in the market. The foreign firm purchases the domestic firm after paying the acquisition price, however, the gain from such a move is the transformation of the game to a full information Cournot game with n firms.

All firms in the market face demand: $P^{A(in)} = a + \theta - Q_{HT}^{A(in)acq} - Q_F^{A(in)acq}$

The foreign firm maximises

$$\Pi_F^{A(in)acq} = P^{A(in)}Q_F^{A(in)acq} - V \quad (3.62)$$

and the remaining $n - 1$ domestic firms

$$\Pi_{Hi}^{A(in)acq} = P^{A(in)}Q_{Hi}^{A(in)acq} - cQ_{Hi}^{A(in)acq} \quad (3.63)$$

Differentiating and solving the system of FOCs, the output set by the foreign firm, the representative domestic firm and total output by all the firms in the market equal:

$$Q_F^{A(in)acq} = \frac{a + \theta + (n - 1)c}{n + 1} \quad (3.64)$$

$$Q_{Hi}^{A(in)acq} = \frac{a + \theta - 2c}{n + 1} \quad (3.65)$$

$$Q_T^{Acq} = \frac{n(a + \theta) - (n - 1)c}{n + 1} \quad (3.66)$$

The profits levels respectively are given by:

$$\Pi_F^{A(in)acq} = \left[\frac{a + \theta + (n - 1)c}{n + 1} \right]^2 - (1 - \beta) \left[\frac{a + t - 2c}{n + 2} + \frac{\theta}{n + 1} \right]^2 - \beta \left[\frac{a - 2c}{n + 2} + \frac{\theta}{n + 1} \right]^2 \quad (3.67)$$

$$\Pi_{Hi}^{A(in)acq} = \left[\frac{a + \theta - 2c}{n + 1} \right]^2 \quad (3.68)$$

and therefore

$$\Pi_{HT}^{A(in)acq} = (n - 1) \left[\frac{a + \theta - 2c}{n + 1} \right]^2 \quad (3.69)$$

Note that the full information obtained by the foreign firm implies that it can ascertain the actual profit levels realized by the domestic firm approached for acquisition under full information in the case of greenfield FDI or exports entry.

As in section 3.4.1 and proposition 16, Proposition 18 summarises the threshold values for the choice of the foreign firm based on the greenfield cost.

Proposition 18 *Suppose there exists information asymmetry among firms and thus domestically owned firms have access to more information regarding demand in the market compared to the foreign firm. Then for all values of a, c, n, t :*

(1) *There exists a unique greenfield investment cost $G' + [c] \in [0, \bar{G}]$, such that iff $G < G' + [c]$ greenfield investment is strictly preferable to acquisition and iff $G > G' + [c]$, the option of acquisition is strictly preferred.*

(2) *There exists a unique greenfield investment cost $G'' \in [0, \bar{G}]$, such that iff $G < G''$ greenfield investment is strictly preferable to exports and iff $G > G''$, the exporting option is strictly preferred.*

Proof. In Appendix C.4 ■

The above proposition implies that greenfield investment is preferable if the greenfield investment cost does not exceed the threshold values. No entry yields no profits for the foreign firm, therefore the firm does not wish to enter the market when facing entry through greenfield investment, if the expected profits from entering are negative, therefore the firm does not enter the market if $G > \frac{(a+nc)^2}{(n+2)^2} \Rightarrow G > \check{G}$. Note that for the purposes of the following analysis this is assumed to be greater than \bar{G} .

3.5.2 Welfare Analysis

In a similar manner to the symmetric case analysed in section 3.4.2, the welfare functions defined under each potential entry mode option are given by the following equations:

$$W^{Ae} = \Pi_{HT}^{A(in)e} + CS^{Ae} \quad (3.70)$$

$$W^{Ag} = \Pi_{HT}^{A(in)g} + CS^{Ag} + G \quad (3.71)$$

$$W^{Aacq} = \Pi_{HT}^{A(in)acq} + CS^{Aacq} + V \quad (3.72)$$

$$W^{Ane} = \Pi_{HT}^{A(in)ne} + CS^{ne} \quad (3.73)$$

In more detail, using the output and price level, the above become:

$$W^{Ae} = n \left[\frac{a+t-2c}{n+2} + \frac{\theta}{n+1} \right]^2 + \frac{1}{2} \left[\frac{(n+1)a-t-nc}{n+2} + \frac{n\theta}{n+1} \right]^2 \quad (3.74)$$

$$W^{Ag} = n \left[\frac{a-2c}{n+2} + \frac{\theta}{n+1} \right]^2 + \frac{1}{2} \left[\frac{(n+1)a-nc}{n+2} + \frac{n\theta}{n+1} \right]^2 + G \quad (3.75)$$

$$\begin{aligned} W^{Aacq} = & (n-1) \left[\frac{a-2c}{n+1} + \frac{\theta}{n+1} \right]^2 + \frac{1}{2} \left[\frac{na-(n-1)c}{n+1} + \frac{n\theta}{n+1} \right]^2 \\ & + \beta \left[\frac{a-2c}{n+2} + \frac{\theta}{n+1} \right]^2 + (1-\beta) \left[\frac{a+t-2c}{n+2} + \frac{\theta}{n+1} \right]^2 \end{aligned} \quad (3.76)$$

and

$$W^{Ane} = \frac{2n(a+\theta-c)^2 + n^2(a+\theta-c)^2}{2(n+1)^2} \quad (3.77)$$

Proposition 19 establishes the threshold values for the choice between the entry modes, by the policy maker.

Proposition 19 *Suppose there exists information asymmetry among firms and thus domestically owned firms have access to more information regarding demand in the market compared to the foreign firm. Then for all values of a, c, n, t :*

(1) *There exists a unique greenfield investment cost $G^{**} + [a] \in [0, \bar{G}]$, such that iff $G > G^{**} + [a]$ greenfield investment is strictly preferable to acquisition and iff $G < G^{**} + [a]$, the option of acquisition is strictly preferred.*

(2) *There exists a unique greenfield investment cost $G^* \in [0, \bar{G}]$, such that iff $G > G^*$ greenfield investment is strictly preferable to exports and iff $G < G^*$, the exporting option is strictly preferred.*

(3) *Lastly, the government will prefer the foreign firm not to enter the market when its entry option is greenfield investment, iff $G < G^{***} + [b]$.*

Proof. In Appendix C.5 ■

3.6 Optimal Policy Measures & Equilibrium Derivation

3.6.1 Optimal Policy Measures

If the entry mode choice of the foreign firm does not coincide with the choice of the host government, then the latter may find it beneficial, in terms of increased welfare to establish policy measures that would induce the firm to change its decision. Thus, the foreign firm would switch its entry mode towards the government's preference.

The government has two policy measures at its disposal: one would be to provide positive incentives that would make its own preferred option more appealing by increasing profits for the firm or to provide negative incentives (a tax) that would make the firm's preferred option less attractive by reducing its profits. If for example the government prefers no entry by the foreign firm, whereas the firm prefers to enter through greenfield investment, then setting a tax on greenfield investment or a subsidy on no entry would lead to the same outcome. Since providing a no entry subsidy is not intuitively correct, the tax on greenfield investment would be the optimal choice. Here, for simplicity reasons, only sub-

sidies are analysed as measures, in view of the fact that a tax and a subsidy can be thought of as equivalent measures. In some situations, where the subsidy analysis is not intuitively correct, the equivalent tax analysis is. A proof of the equivalence between the subsidies in favour of the government's optimal option and the tax 'against' the firm's optimal option can be found in Appendix C.11.

From the host government perspective, the maximum subsidy they are willing to provide equals the difference between the welfare level corresponding to the government's entry mode choice and the welfare corresponding to the firm's optimal choice. This can be described, by the following expression, in terms of functions:

$$E(W_p^{mk}) - S_p^{mk(l)} \succeq E(W_p^{ml}) \Leftrightarrow S_p^{mk(l)} \leq E(W_p^{mk}) - E(W_p^{ml}) \quad (3.78)$$

Therefore $S_p^{mk(l)} = E(W_p^{mk}) - E(W_p^{ml})$ is the maximum level of subsidy the policy maker would be willing to provide, where $m \in [A, S]$ denotes asymmetry and symmetry, $k \in [e, g, acq, ne]$ denotes the government's optimal choice and $l \in [e, g, acq, ne]$ the foreign firm's choice. Note that no policy measure is required in the case where $k = l$. The subscript p denotes the policymaker. Note that for the subsidy provided, for the superscript $mk(l)$, m defines the particular information case we refer to and for $k(l)$ the term inside the brackets denotes the firm's optimal entry mode, away from which the policy maker wishes to move through the policy measure provision and the term outside the brackets denotes the government's preferred entry mode, towards which the policy maker wishes the firm to move.

From the firm's perspective, the incentives that the policy maker provides must match the incentives that the foreign firm is willing to accept in order to be induced to switch its

optimal mode. This will be defined by the difference between the profits the firm realizes when it chooses the government's preferred entry mode and the profits it realizes when it chooses its own preferred mode. Here, the superscript F denotes the foreign firm. In terms of a function this can be written:

$$E(\Pi_F^{mk}) + S_F^{mk(l)} \succeq E(\Pi_F^{ml}) \Leftrightarrow S_F^{mk(l)} \succeq E(\Pi_F^{ml}) - E(\Pi_F^{mk}) \quad (3.79)$$

Therefore the minimum subsidy the firm is willing to accept in order to switch its mode is equal to: $S_F^{mk(l)} = E(\Pi_F^{ml}) - E(\Pi_F^{mk})$.

It is clear from the above that for a successful switch, the maximum amount of the policy measure provided by the host government must be greater than the minimum amount the firm is willing to accept. Alternatively, if the policy measure provided is lower than the measure the firm is willing to accept, then no mode switch will take place and the firm will enter through its own preferred mode.

A. No mode switch

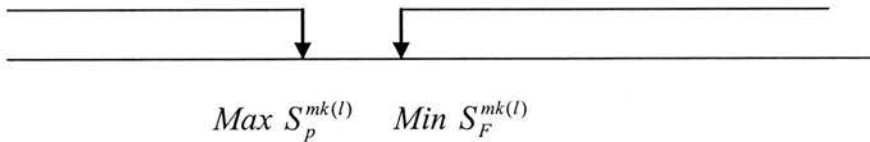


Figure 1: No Mode Switch

B. Mode Switch

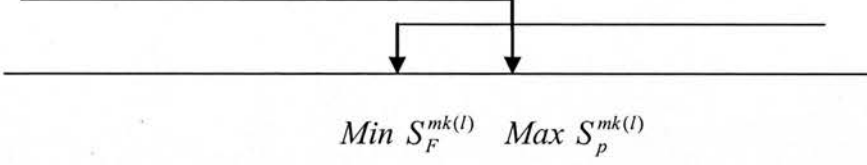


Figure 2: Mode Switch

Taking as an example the case where the government prefers exports to the Greenfield investment choice of the firm, then the government sets its optimal policy measure, as previously described, through the comparison of the welfare levels for the exports entry and the greenfield investment choice. Thus, for the symmetric information case,

$$E(W_p^{Se}) - S_p^{Se(g)} \succeq E(W_p^{Sg}) \Leftrightarrow S_p^{Se(g)} \leq E(W_p^{Se}) - E(W_p^{Sg}) \quad (3.80)$$

The maximum policy measure is given by

$$S_p^{Se(g)} = E(W_p^{Se}) - E(W_p^{Sg}) \quad (3.81)$$

and in particular

$$S_p^{Se(g)} = \frac{2n(a - 2c + t)^2 + [(n + 1)a - nc - t]^2 - 2n(a - 2c)^2}{2(n + 2)^2} + \frac{(n + 2)t(a - (n + 1)t + nc) - [(n + 1)a - nc]^2}{2(n + 2)^2} - G \quad (3.82)$$

\Leftrightarrow

$$S_p^{Se(g)} = G^* - G$$

Turning to the firm, the minimum subsidy accepted is defined by the comparison of the profits in the case of exports and in the case of greenfield investment

$$E(\Pi_F^{Se}) + S_F^{Se(g)} \succeq E(\Pi_F^{Sg}) \Leftrightarrow S_F^{Se(g)} \succeq E(\Pi_F^{Sg}) - E(\Pi_F^{Se}) \quad (3.83)$$

The minimum subsidy equals: $S_F^{Se(g)} = E(\Pi_F^{Sg}) - E(\Pi_F^{Se}) \Leftrightarrow$

$$S_F^{Se(g)} = \frac{(a + nc)^2 - (a + nc - (n + 1)t)^2}{(n + 2)^2} - G \quad (3.84)$$

\Leftrightarrow

$$S_F^{Se(g)} = G'' - G \quad (3.85)$$

The determination of the potential mode switch, therefore depends on the following condition:

$$S_p^{Se(g)} > S_F^{Se(g)} \Leftrightarrow G^* > G'' \quad (3.86)$$

The remaining mode switch conditions are summarised in Appendix C.6, in Tables 1, 2 and 3.

3.6.2 Equilibrium Derivation

The above analysis has provided the preferred entry modes for the foreign firm wishing to enter the host market and the government of the country using the probable level of Greenfield investment as a reference point, separately. The policy measures required for successful mode switches, when there is a discrepancy between the firm's and the host government's entry mode have been summarized in the previous section. Following Horstmann and Markusen [48], a simple simulation exercise is used to 'obtain some insight' in the entry mode to be chosen in equilibrium, when the host government intervenes through the setting of subsidies. Using a simulation approach that aims to vary the values of each parameter in turn (keeping the remaining values constant) we aim to analyze the potential policy

measures that could be provided, their effectiveness in terms of mode switch achievement and the final equilibrium entry mode choices.

The simulation results that have been derived, complying with non negativity constraints are found in Appendix C.7. Using the simulation results, we can make the distinction between the results of a small and large market, depending on the variation of the following 4 parameters: production cost, tariff, number of domestic firms and the variation of the asymmetry parameter. Note that as previously mentioned, the acquisition price will depend on the probability of the greenfield cost being below or above a particular threshold level ($G > G''$ for $\beta = 0$ and $G < G''$ for $\beta = 1$). We used both values for the simulation and the observation is that the rankings do not change, with the exception of the small market when there is a tariff variation. Thus for preserving space the same graphs will be used in this following analysis, with solely the threshold ranking results presented separately. The case of tariff variation will be presented in separate graphs. The interpretation of a small market can be in terms of development, size etc. Bringing together the rankings for the symmetric and asymmetric cases, the graphs bellow display the rankings and equivalence mode preferences of the foreign firm and the domestic policy maker. Note that in the situation where the simulation results for the particular threshold values are negative, the ranking will be displayed on the graph, however, the analysis will begin for the value of zero, as the Greenfield investment cost can take values from the following interval: $G \in [0, \overline{G}]$. Note that for $\beta = 0$ we look at situations where $G > G''$ and for $\beta = 1$ we look at situations where $G < G''$. In all the tables (tables 4-14), the second column shows the interval from the equivalent figure (figures 3-13) to which they correspond, columns three

and four show the preferred entry mode by the government and firm respectively. Columns 5 displays whether a mode switch takes place and column 6 provides the equilibrium entry mode.

Tables for the numerical exercise undertaken, leading to the below results are provided in Appendices 8, 9 and 10.

Small Market ($a = 10$)

Base Case

Starting the analysis, we examine the situation where the market is small, captured by a low value of a ($a = 10$) and the levels of the cost, tariff, number of firms and the variation σ^2 are low. ²²

The simulation provides the rankings of the threshold values, as seen in the following figure:

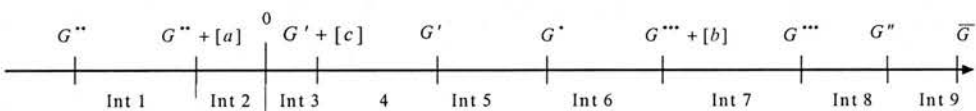


Figure 3: Base case

²² Tables for this numerical exercise are provided in Appendix 7.

BASE	Interval	Government	Firm	Switch	Equilibrium
$\beta=1$	3	No Entry	Greenfield	No	Greenfield
	4	No Entry	Greenfield (S)	No	Greenfield (S)
			Acquisition (A)		Acquisition (A)
	5,6	No Entry	Acquisition	No	Acquisition
	7	No Entry (S)	Acquisition	No (S)	Acquisition (S)
		Greenfield (A)		Yes (A)	Greenfield (A)
	8	Greenfield	Acquisition	Yes	Greenfield
$\beta=0$	9	Greenfield	Acquisition	Yes	Greenfield

Table 4: Base Case summary

This base case, involves greenfield FDI as the equilibrium outcome, in four intervals both for the case of symmetry and asymmetry. Successful mode switching from acquisition to the greenfield FDI choice by the government takes place in three intervals for the case of asymmetry (in 7,8,9) and in two for the case of symmetry (8 and 9), as seen in Table 4.

Case 1- High Cost

When the cost level is increased, with the remaining variables constant, the following figure summarizes the threshold rankings and table 5 provides a summary of the equilibrium modes.

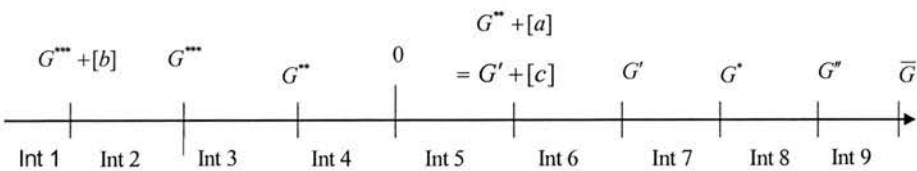


Figure 4: High Cost

High variation	Interval	Government	Firm	Switch	Equilibrium
$\beta = 1$	5	Exports	Greenfield	No	Greenfield
	6	Exports	Greenfield (S)	No (S)	Greenfield (S)
			Acquisition (A)	Yes (A)	Exports (A)
	7	Exports	Acquisition	Yes	Exports
	8	Greenfield	Acquisition	Yes (S)	Greenfield (S)
				No (A)	Acquisition (A)
$\beta = 0$	9	Greenfield	Acquisition	Yes (S)	Greenfield (S)
				No (A)	Acquisition (A)

Table 5: High Cost Summary

This case, involves greenfield FDI as the equilibrium outcome in all but one intervals, when there is symmetric information and acquisition is mostly chosen when there is asymmetric information in the market. In terms of mode switching, this is successful when the market is characterized by informational symmetry, hence we observe a switch from acquisition to greenfield FDI in intervals 8 and 9, under symmetry. A mode switch from acquisition to exports also occurs, in interval 7 and interval 6 in the asymmetric case, as the policy measure provided by the policy maker is high enough to induce the firm to switch entry mode.

Case 2- High Tariff

When the import tariff is raised, without altering the value of the remaining variables, the ranking is given by figure 5, for $\beta = 1$ and figure 6 for $\beta = 0$. Tables 6 and 7 summarise the equilibrium outcomes respectively.

For $\beta = 1$ (i.e. greenfield investment is the outside option for acquisition)

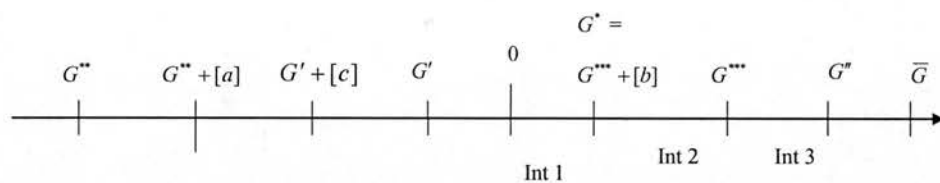


Figure 5: High Tariff

High tariff	Interval	Government	Firm	Switch	Equilibrium
$\beta=1$	1	No Entry	Acquisition	No	Acquisition
	2	No Entry (S)	Acquisition	No (S)	Acquisition (S)
		Greenfield (A)		Yes (A)	Greenfield (A)
	3	Greenfield	Acquisition	Yes	Greenfield

Table 6: High Tariff summary

The observation is that successful mode switches from acquisition to greenfield investment take place in intervals 2 and 3, when informational asymmetry exists and in interval 3 only when there is symmetry. Thus for informational symmetry acquisition is chosen for two intervals whereas two intervals display greenfield investment when there is asymmetry in the information level.

For $\beta = 0$ (i.e. exports is the outside option for acquisition)

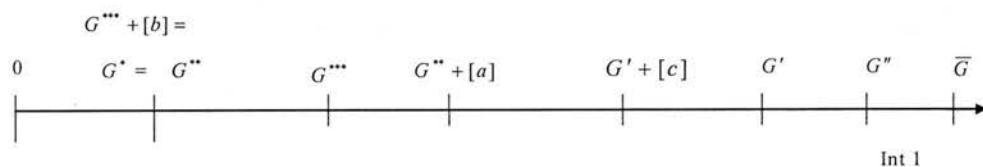


Figure 6: High Tariff

High tariff	Interval	Government	Firm	Switch	Equilibrium
$\beta=0$	1	Greenfield	Acquisition	Yes	Greenfield

Table 7: High Tariff

In this situation, there is a mode switch from acquisition to greenfield investment.

Case 3- High number of firms

When n is high, the competition in the market increases. The following figure displays the ranking of the threshold values.

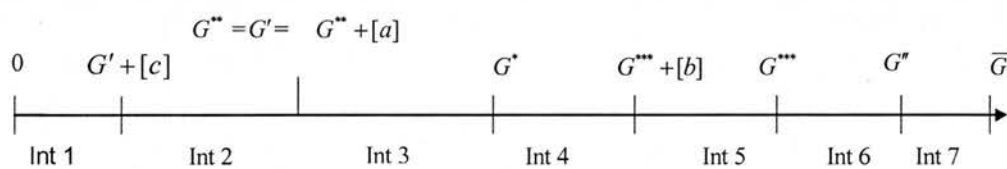


Figure 7: High Number of Firms

High n	Interval	Government	Firm	Switch	Equilibrium
$\beta=1$	1	No Entry	Greenfield	No	Greenfield
	2	No Entry	Greenfield (S)	No	Greenfield (S)
			Acquisition (A)		Acquisition (A)
	3,4	No Entry	Acquisition	No	Acquisition
	5	No Entry (S)	Acquisition	No	Acquisition
		Greenfield (A)			
	6	Greenfield	Acquisition	Yes	Greenfield
$\beta=0$	7	Greenfield	Acquisition	Yes	Greenfield

Table 8: High Number of Firms

The above table shows that when the government prefers no entry, it is unable to induce the foreign firm not to enter the market. Thus the MNE will prefer to enter through greenfield investment for intervals 1 and 2 for symmetry and acquisition for intervals 3,4

and 5. When there is asymmetric information, acquisition is chosen over no entry for more intervals. Mode switch from acquisition to greenfield FDI takes place for intervals 6 and 7.

Case 4- High variation

Lastly, when the variation of θ is high, the ranking is given in figure 8.

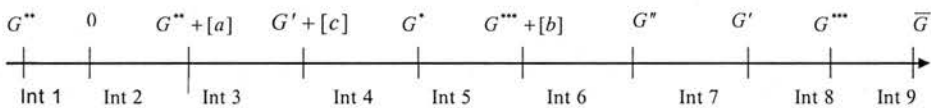


Figure 8: High variation

High variation	Interval	Government	Firm	Switch	Equilibrium
$\beta = 1$	2,3	No Entry	Greenfield	No (S)	Greenfield (S)
				Yes (A)	No Entry (A)
	4,5	No Entry	Greenfield (S)	No	Greenfield (S)
			Acquisition (A)		Acquisition (A)
	6	No Entry (S)	Greenfield (S)	No (S)	Greenfield (S)
		Greenfield (A)	Acquisition (A)	Yes (A)	Greenfield (A)
$\beta = 0$	7,8	No Entry (S)	Exports (S)	No (S)	Exports (S)
		Greenfield (A)	Acquisition (A)	Yes (A)	Greenfield (A)
	9	Greenfield	Exports (S)	Yes (S)	Greenfield
			Acquisition (A)	Yes (A)	

Table 9: High Variation

Table 9 summarizes the equilibrium outcomes, with switching taking place when the government prefers no entry by the foreign firm for the asymmetric case in intervals 2,3. In all situations where the firm prefers acquisition, in contrast to the greenfield investment choice of the government, a mode switch will take place. Greenfield appears to be the prevailing equilibrium entry mode.

LARGE MARKET ($a = 100$)

Base Case

When referring to a large market, as captured by the setting of $a = 100$, figure 9 provides the threshold rankings:

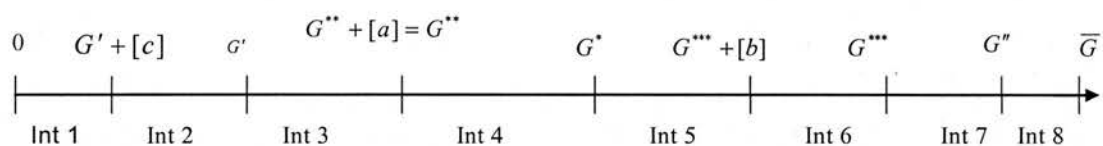


Figure 9: Base Case

BASE	Interval	Government	Firm	Switch	Equilibrium
$\beta=1$	1	No Entry	Greenfield	No	Greenfield
	2	No Entry	Greenfield(S) Acquisition(A)	No	Greenfield(S) Acquisition(A)
	3,4,5	No Entry	Acquisition	No	Acquisition
	6	No Entry (S) Greenfield (A)	Acquisition	No	Acquisition
	7	Greenfield	Acquisition	No	Acquisition
$\beta=0$	8	Greenfield	Acquisition	No	Acquisition

Table 10: Base Case

The main observation is that no mode switch takes place for any of the intervals. Acquisition is the prevailing entry mode, with greenfield Investment chosen for only one interval (1) when there is informational asymmetry and two (1,2) for the case of information symmetry.

Case 1- High Cost

When the cost of production increases, with the remaining variables constant, the following ranking is derived, through the exercise. Then table 11 provides the summary of

the equilibrium outcomes.

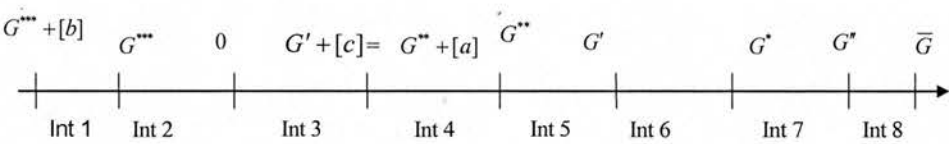


Figure 10: High Cost

High Cost	Interval	Government	Firm	Switch	Equilibrium
$\beta=1$	3	Exports	Greenfield	No	Greenfield
	4,5	Exports	Greenfield(S) Acquisition(A)	No	Greenfield(S) Acquisition(A)
	6	Exports	Acquisition	No	Acquisition
$\beta=0$	7	Greenfield	Acquisition	Yes (S)	Greenfield (S)
				No (A)	Acquisition (A)
	8	Greenfield	Acquisition	Yes (S) No (A)	Greenfield (S) Acquisition (A)

Table 11: High Cost

In contrast to the base case, a mode switch will take place in intervals 7 and 8 under information symmetry, where the firm will change its entry mode from acquisition to the greenfield investment preference of the government. When there is information asymmetry, no mode switch takes place and the prevailing entry mode is acquisition.

Case 2- High Tariff

The ranking in the case of higher import tariffs compared to the base case is summarized in figure 11. The main observation is that it is identical to figure 9 and thus the increased tariff does not alter the ranking.

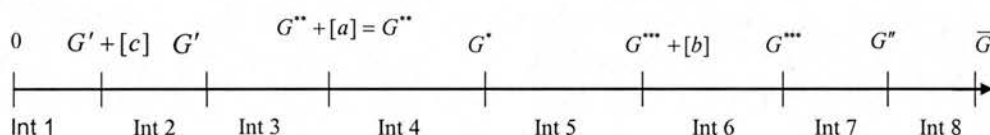


Figure 11: High Tariff

High Tariff	Interval	Government	Firm	Switch	Equilibrium
$\beta=1$	1	No Entry	Greenfield	No	Greenfield
	2	No Entry	Greenfield (S) Acquisition (A)	No	Greenfield (S) Acquisition (A)
	3,4,5	No Entry	Acquisition	No	Acquisition
	6	No Entry (S) Greenfield (A)	Acquisition	No	Acquisition
	7	Greenfield	Acquisition	No	Acquisition
$\beta=0$	8	Greenfield	Acquisition	No	Acquisition

Table 12: High Tariff

When the import tariffs increased, the same results hold in terms of the mode switch as in the base case, since no entry mode switch is induced by the proposed policy measures by the government. Acquisition is the prevailing entry mode.

Case 3 - High number of firms

When the number of domestic firms in the market increases the ranking of the threshold values is the same as in the base case, as shown by figure 12.

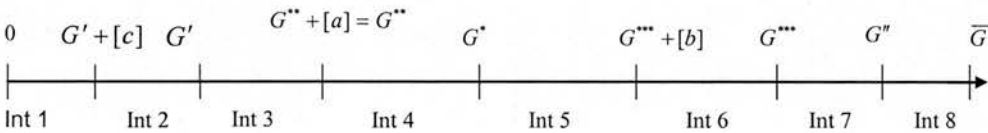


Figure 12: High Number of Firms

High n	Interval	Government	Firm	Switch	Equilibrium
$\beta=1$	1	No Entry	Greenfield	No	Greenfield
	2	No Entry	Greenfield (S)	No	Greenfield (S)
			Acquisition (A)		Acquisition (A)
	3,4,5	No Entry	Acquisition	No	Acquisition
	6	No Entry (S)	Acquisition	No	Acquisition
		Greenfield (A)			
	7	Greenfield	Acquisition	No	Acquisition
$\beta=0$	8	Greenfield	Acquisition	No	Acquisition

Table 13: High Number of Firms

Therefore, the summary of the equilibrium outcomes displayed in figure 12 is identical to the one in table 10 (base case) and no mode switching takes place for any of the intervals.

Case 4- High variation

Lastly, when the variation of parameter θ increases, as in the previously discusses cases, the rankings remain unaltered compared to the base case, described by figure 9, as seen below in figure 13.

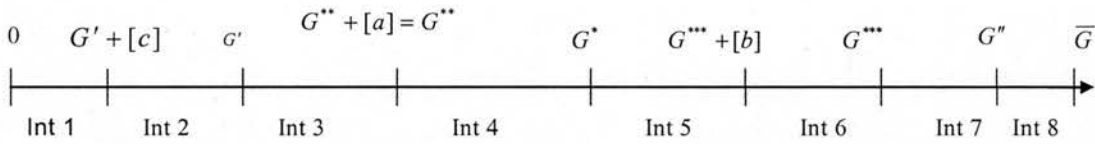


Figure 13: High Variation

High variation	Interval	Government	Firm	Switch	Equilibrium
$\beta=1$	1	No Entry	Greenfield	No	Greenfield
	2	No Entry	Greenfield(S) Acquisition(A)	No	Greenfield(S) Acquisition(A)
	3,4,5	No Entry	Acquisition	No	Acquisition
	6	No Entry (S) Greenfield(A)	Acquisition	No	Acquisition
	7	Greenfield	Acquisition	No	Acquisition
$\beta=0$	8	Greenfield	Acquisition	No	Acquisition

Table 14: High Variance

Thus no entry mode takes place and the prevailing equilibrium mode is acquisition.

3.6.3 Comparisons

Assessing the above equilibria derivation, as summarized in tables 4-14, when government intervention policies exist, leads to the following observations :

Small Market versus Large Market

The small market, defined here by $a = 10$, is characterized by Greenfield FDI as the prevailing equilibrium outcome, whereas acquisition is more prominent in the large market ($a = 100$) both in the symmetric and the asymmetric framework. Greenfield FDI and acquisition appear to be the two entry modes that are more likely to lead to a mode

switch when compared, particularly in the small market framework. This is a result of the fact that in the small market the condition for a mode switch from acquisition to Greenfield investment always holds, whereas in the large market it does not.

In the small market, when acquisition and greenfield FDI are the preferred entry modes of the firm and government respectively, the observation is that in the majority of the comparisons (apart from the case of n increase), the switch mode conditions hold. Thus successful mode changes to the government's preference take place. In contrast, these conditions, for the same compared modes do not hold for any of the examined cases in the large market framework.

An interpretation of this result is that a small market is not developed enough for the domestic firms to be appealing in terms of the technology level, in such a way that will allow the cost efficiency of the foreign firm to be maintained upon entry in the host country. Thus the firm will opt for Greenfield investment to ensure that the low cost of production (zero for the benefit of the above analysis) is sustained. The opposite holds when the host country is large; the plants of the domestic firms are already advanced and hence allow for the upholding of the cost efficiency levels, thus the optimal choice of the firm will be an acquisition. This finding is in line with Nocke and Yeaple [64] in which they show that the more developed the host country, the more likely it is that the entry mode is acquisition.

In the small market in case 3, when the number of domestic firm increases, the smaller likelihood to have a mode switch from acquisition to Greenfield investment in comparison to the remaining cases, could be attributed to the fact, that the profits for the individual firm (that will constitute the base for the acquisition price) will be smaller as the number of firms

increases due to the increased competition in the domestic market. It is thus more likely that the cost of acquiring a domestic firm is smaller than the cost of building a new plant. The incentive provided by the policymaker, although in the remaining cases is sufficient for a mode switch, in this situation, the gain from acquiring a domestic firm instead of building a plant is much greater than the policy measure provided to ensure a switch.

Also exports are more likely to be the choice of the government in the large market rather than in the small. This can be explained by the fact that the small market can be served efficiently by a small number of firms (that is consumers' surplus can be high in a small market even if only a small number of firms produces) whereas the same number of firms may be producing at a level that allows for a small level of consumers' surplus. This implies that in the small market the government may place a small weight on consumers and allow the low level of competition. In the larger market however, this effect may be reversed and importing from the foreign firm increases not only consumers' gain, but also the tariff revenue gain.

Symmetry vs Asymmetry

Comparing the results, in terms of the small market, we observe that in asymmetry there is no change in the equilibrium outcomes as a result of the increase in the variation of the asymmetry parameter or an increase in the tariff level.

The main changes occur in the case of an increase in the cost level for the symmetric and asymmetric cases. In the case of symmetry Greenfield becomes more prominent as an equilibrium entry mode, whereas in asymmetry Greenfield is less prominent and on occa-

sion, for the small market case, it is replaced by exports. As c increases, the preferred entry mode of the government changes in some instances from no entry to exports in both the symmetric and asymmetric cases. It is clear that relying on the internal domestic production when the cost increases, imposes a strain not only on profits but also on consumers. Importing goods from the cost efficient foreign firm allows for the correction of the latter effect (on consumers). When compared, however to the preferred entry mode of the firm (in order to obtain the equilibrium mode), then for the symmetric case the comparison to the acquisition choice of the firm to exports allows for a mode switch, when the market is small, as does the comparison of acquisition to greenfield investment. Thus in the symmetric case the change of the government's entry choice will imply more likelihood of a mode switch and so Greenfield is more prominent. In the asymmetric case, for the increase in the cost level, the comparison to the acquisition choice of the firm will allow for a mode switch to exports in the small market framework, however, the comparison of Greenfield investment (government's choice) to acquisition (firm's choice) does not lead to a mode switch, and so acquisition and exports replace Greenfield as an equilibrium mode in some instances, when compared to the base case.

In the case of a firms' number increase, particularly for the large market, the observation is that acquisition becomes more prominent as an equilibrium entry mode, as this increases competition for the domestic firms, thus the profits for the outside options, the acquisition price, are reduced, thus making acquisition less expensive.

In the asymmetric case there will always be a switch from acquisition to Greenfield investment as the condition $G' + [c] > G^{**} + [a]$ generally holds for the small market para-

meter variation. The exception to this is the situation where the cost parameter increases. In the large market however, the condition does not hold and so the original acquisition choice of the firm will prevail. A switch also takes place in the small market under the asymmetry assumption, when the variation parameter is high; then the firm chooses not to enter the market, induced to switch to no entry from its greenfield investment optimal option, as the relevant policy measure is high.

For the case of a large market, no changes occur following the increase in the tariff, the number of domestic firms or for the case of variations in parameter θ .

Changes in the equilibrium entry modes occur in the small market when the level of the production cost alters mainly in the symmetric information framework as seen in Table 5. The results again reveal that Greenfield becomes more prominent in the symmetric case as a mode change from acquisition to Greenfield will take place in contrast to the base case whereas in the asymmetric case acquisition will be preferred by firms more often leaving this option to become the entry mode in more intervals. In contrast to this, for the small market, the increase in σ^2 , will lead to mode switches in the case of asymmetry rather than symmetry, as observed in table 9.

General Observations

One main conclusion stemming from the above analysis is that foreign direct investment in the form of either Greenfield or Brownfield FDI is preferable to exports in equilibrium.

In terms of mode switch, there is a limited amount of cases that the firm will alter its entry choice. This is more likely to occur in terms of a mode change from acquisition to Greenfield. The policy measure provided for such a change can be accounted for as a tax that makes an acquisition less attractive as an entry mode and increases the attractiveness of Greenfield investment. This measure on the other hand can be seen as a subsidy that decreases the cost of Greenfield investment and thus makes it more likely as an entry mode choice.

In terms of the equilibrium choice, it is clear from the above that Greenfield investment is the most prominent equilibrium entry mode for a small market, whereas in the case of a large market, the acquisition of an existing domestic firm will be chosen more often by the foreign firm seeking access to the domestic market.

A mode switch is more likely to occur in the case of a small market than in the case of a large market. This can be attributed to the fact that a larger market is likely to provide higher profits for the foreign firm that seeks entrance and thus any measure provided by the government will not be high enough to cover for the difference in the profits from a mode switch. A smaller market on the other hand, will not provide very high profit incentives and thus the government will have more chances of succeeding in the incentivisation for a mode switch.

3.7 Concluding Remarks

The aim of the above analysis was to examine the equilibrium entry mode of a foreign firm wishing to enter a market, when the firm faces three potential entry types, namely;

Greenfield investment, acquisition and exporting. Thus we appraise the above in a framework that allows exports (imports from the host country point of view) to be viewed as an endogenous entry mode.

The analysis in both a symmetric and asymmetric framework aims to examine the effective role of the policymaker in an effort to shift the preference of the foreign firm from a particular entry mode towards the most preferred by the government, in the case of a discrepancy between the two.

The observations of the simulation approach adopted reveals that successful mode switches occur from acquisition to Greenfield investment mainly (on occasion from acquisition to exports too) when the market is small and thus the profits captured by the foreign firm are smaller, rather than in a larger market. As the policy measure (compensation for the firm) will depend on the profits, a smaller market will allow the government to cover the difference in profits of a switch. As a larger market allows for higher profits from the firm's preferred mode, the host government will be less able to cover the difference in the form of compensation (in the form of a subsidy) or profits will still be higher than the government's preferred entry mode's when a tax is imposed as a punishment, thus not allowing for a mode switch.

Concluding, greenfield investment and acquisitions will be the most prominent entry modes in this framework, thus supporting the findings of the WTO report in 2006 [73], prior to the economic crisis that negatively affected international transactions. In terms of the market size, Greenfield investment is more prominent when the market is small, whereas in the case of a large market, acquisition is more prevalent. Also, the government

will be able to play an active role , particularly when the change of entry mode is between acquisition and greenfield investment.

Chapter 4

Conclusion

In conclusion, the analysis of this work consists of three separate chapters that have contributed to the literature in the following ways:

Chapter 1 has used a lobbying contest as an identification mechanism, providing thus a solution to the inability of the policymaker in a *a la Dixit* oligopolistic market characterised by cost asymmetry, to create a 'National Champion' to successfully compete with its foreign rival in the third market setting, a result of the existence of incomplete information. The most efficient in terms of cost firm will be the winner of the contest and will be the recipient of the award, the subsidization of their production for exports. It will then proceed to compete with a rival monopoly in the importing third country *a la Brander and Spencer*. The contest is used both in the case where the policy measure is a pure transfer and when it is not, and the conditions under which the lobbying contest intervention is welfare improving have been examined.

Chapter 2 has aimed at the examination of all the potential cooperational agreements that can arise in a strategic trade setting, where the monopolistic firms of two producing countries receive strategic protectionist measures in the form of subsidies. The comparison of profits and welfare levels in these cooperational situations and the non cooperational outcome of Brander and Spencer under cost asymmetry has assisted in establishing whether such agreements would be profit and welfare enhancing, firstly in a constant and then in a decreasing marginal cost framework. The main conclusion reached is that the level of the

consumers' surplus share, the extent of the cost asymmetry and the market size will define the final outcome.

Chapter 3 examines the role of government intervention in influencing the entry mode that a foreign firm would choose when entering a market. Direct policy measures are used, following the suggestion of Nocke and Yeaple [64] regarding the analysis of policy implications when the preferred entry mode of the host country differs from the one of the entering firm and potential incentivisation techniques for a change of mode promotion. The main observation of the above examination is that policy intervention can be effective, in particular for small markets as the firm can be incentivised to alter its mode from acquisition to greenfield investment. One more feature of this analysis is that FDI is the prominent entry mode, whether in the form of Greenfield investment or acquisition as reports such as the UNCTAD investment report in 2006 shows.

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Appendix A

Appendix for Chapter 1

A.1 Welfare Levels $\delta = 1$

a la *Dixit Oligopoly with cost Asymmetry*

For the case described by the Dixit model, where there is competition between the n oligopolistic firms in country 1, and thus all the domestic firms receive the per unit subsidy, then each of the firms sets its optimal production level through the maximisation of its own profit function. The firms, as mentioned above differ in their production costs, so we have $c_{11} \geq c_{12} \geq \dots \geq c_{1n}$. Therefore:

$$\Pi_{11} = P(Q)X_{11} - c_{11}X_{11} + sX_{11}$$

$$\Pi_{12} = P(Q)X_{12} - c_{12}X_{12} + sX_{12}$$

...

$$\Pi_{1n} = P(Q)X_{1n} - c_{1n}X_{1n} + sX_{1n}$$

where $X_{11}, X_{12}, \dots, X_{1n}$ and $\Pi_{11}, \Pi_{12}, \dots, \Pi_{1n}$, denote production and profits of country 1 firm 1, 2, ... n respectively,

The same applies for the monopolistic rival foreign firm:

$$\Pi_2 = P(Q)X_2 - c_2X_2$$

where X_2 denotes production and Π_2 profits for firm 2 in country 2.

The inverse demand function is given by:

$$P(Q) = a - b(X_{11} + X_{12} + \dots + X_{1n} + X_2)$$

Through the use of the first order conditions, the following expressions for the production levels of the domestic and the foreign firms are obtained:

$$\begin{aligned} X_{11} &= \frac{a - b(X_{12} + X_{13} + \dots X_{1n}) - bX_2 - c_{11} + s}{2b} \\ X_{12} &= \frac{a - b(X_{11} + X_{13} + \dots X_{1n}) - bX_2 - c_{12} + s}{2b} \\ &\dots \\ X_{1n} &= \frac{a - b(X_{11} + X_{12} + \dots X_{1n-1}) - bX_2 - c_{1n} + s}{2b} \end{aligned}$$

and

$$X_2 = \frac{a - b \sum_{i=1}^n X_{1i} - c_2}{2b}$$

The total production level in country 1 is obtained through the summation of the individual film production levels:

$$X^D = X_{11} + X_{12} + \dots + X_{1n} = \frac{n(a + s) - nbX_2 - \sum_{i=1}^n c_{1i}}{(n + 1)b}$$

This implies that the simultaneous solution of the two functions: X^D and X_2 the following expressions for the output levels are obtained:

$$X_2 = \frac{a - ns + \sum_{i=1}^n c_{1i} - (n + 1)c_2}{(n + 2)b}$$

and

$$X^D = \frac{na + 2ns - 2 \sum_{i=1}^n c_{1i} + nc_2}{(n + 2)b}$$

Then the total output level exported to the third country and the inverse demand function are given respectively by:

$$Q^D = X^D + X_2 = \frac{(n+1)a + ns - \sum_{i=1}^n c_{1i} - c_2}{(n+2)b}$$

and

$$P(Q^D) = \frac{a - ns + \sum_{i=1}^n c_{1i} + c_2}{(n+2)}$$

In order to set that optimal subsidisation level, the government maximises its objective function, given by the domestic welfare level. Then:

$$W^D = P(Q)X^D + sX^D - \sum_{i=1}^n (c_{1i}X_{1i}) - sX^D = P(Q)X^D - \sum_{i=1}^n (c_{1i}X_{1i})$$

where the total cost level is obtained through the following:

$$X_{11} = \frac{a - b(X_{12} + X_{13} + \dots X_{1n}) - bX_2 - c_{11} + s}{2b}$$

and

$$X^D - X_{11} = X_{12} + X_{13} + \dots X_{1n}$$

\Rightarrow

$$X_{11} = \frac{a - b(X^D - X_{11}) - bX_2 - c_{11} + s}{2b} \Rightarrow$$

$$X_{11} = \frac{a - bQ^D - c_{11} + s}{b} \Rightarrow$$

$$X_{11} = \frac{a + c_2 + \sum_{i=1}^n c_{1i} - (n+2)c_{11} + 2s}{(n+2)b}$$

Thus

$$\begin{aligned}
 c_{11}X_{11} &= \frac{ac_{11} + c_{11}c_2 + c_{11}\sum_{i=1}^n c_{1i} - (n+2)(c_{11})^2 + 2sc_{11}}{(n+2)b} \\
 c_{12}X_{12} &= \frac{ac_{12} + c_{12}c_2 + c_{12}\sum_{i=1}^n c_{1i} - (n+2)(c_{12})^2 + 2sc_{12}}{(n+2)b} \\
 &\dots \\
 c_{1n}X_{1n} &= \frac{ac_{1n} + c_{1n}c_2 + c_{1n}\sum_{i=1}^n c_{1i} - (n+2)(c_{1n})^2 + 2sc_{1n}}{(n+2)b}
 \end{aligned}$$

Summing:

$$\sum_{i=1}^n c_{1i}X_{1i} = \frac{a\sum_{i=1}^n c_{1i} + c_2\sum_{i=1}^n c_{1i} + (\sum_{i=1}^n c_{1i})^2 - (n+2)\sum_{i=1}^n (c_{1i})^2 + 2s\sum_{i=1}^n c_{1i}}{(n+2)b}$$

Maximising with respect to the subsidy level and solving for the optimal protectionist

measure ($\frac{dW}{ds} = 0$) leads to the following result:

$$s = -\frac{(n-2)(na + nc_2 - 2\sum_{i=1}^n c_{1i})}{4n^2}$$

Note that the non negativity constraint here requires that for positive production by the lowest cost firm:

$$\begin{aligned}
 s &> \frac{(n+2)c_1^* - a - c_2 - \sum_{i=1}^n c_{1i}}{2} \\
 \Rightarrow -\frac{(n-2)(na + nc_2 - 2\sum_{i=1}^n c_{1i})}{4n^2} &> -\frac{(n+2)c_1^* - a - c_2 - \sum_{i=1}^n c_{1i}}{2} \\
 \Rightarrow 4(n+1)n(\sum_{i=1}^n c_{1i} - nc_1^*) + 2n(n-2)(a + c_2) + 8\sum_{i=1}^n c_{1i} &> 0
 \end{aligned}$$

Note that the n firms in the market are ranked as follows: $c_{11} \geq c_{12} \geq \dots \geq c_{1n}$.

We know that c_1^* is the lowest cost in the market. Therefore, the difference:

$$c_{11} - c_1^* > 0$$

is positive as firm 1 will either be the lowest cost firm in the market or will operate at a higher cost. The same applies for all the remaining firms in the market and thus in sum

$$\sum_{i=1}^n c_{1i} - nc_1^* > 0$$

Therefore the lowest cost firm will be providing a positive output. The same principle applies for total production, where the condition becomes:

$$3n^2 + 2n > 0$$

thus the total production in the oligopolistic situation is positive.

Then, by substituting in the production level expression from above, we obtain the following:

$$X^D = \frac{an + c_2n - \sum_{i=1}^n c_{1i}}{2bn}$$

and the inverse demand function:

$$P = \frac{an + nc_2 + 2(\sum_{i=1}^n c_{1i})}{4n}$$

Therefore the welfare level is given by:

$$W^D = \frac{[n(a + c_2) - 2\sum_{i=1}^n c_{1i}]^2 + 8n[n\sum_{i=1}^n (c_{1i})^2 - (\sum_{i=1}^n c_{1i})^2]}{8bn^2}$$

Lobbying Contest

Turning to the derivation of the welfare function in the case where the lobbying contest leads to the elimination of the $(n-1)$ inefficient firms in the market through the contest. Then, again, in the second stage, the two competing firms set their optimal production levels through the maximisation of the profit functions:

$$\Pi_1^* = P(Q)X_1^* - c_1^*X_1^* + s_1^*X_1^*$$

and

$$\Pi_2 = P(Q)X_2 - c_2X_2$$

Again, the inverse demand function is given by:

$$P(Q) = a - bQ^L = a - b(X_1^* + X_2)$$

Maximising and solving as previously, we obtain:

$$X_1^* = \frac{a - 2c_1^* + c_2 + 2s_1^*}{3b}$$

and

$$X_2 = \frac{a - 2c_2 + c_1^* - s_1^*}{3b}$$

Then, as in the previous section, we maximise the domestic welfare function with respect to the subsidy, and obtain the optimal level of this policy measure.

$$s_1^* = \frac{a - 2c_1^* + c_2}{4}$$

By substituting where required, we obtain:

$$X^L = X_1^* = \frac{a - 2c_1^* + c_2}{2b}$$

and

$$X_2 = \frac{a - 3c_2 + 2c_1^*}{4b}$$

The total output and the inverse demand function respectively equal:

$$Q = \frac{3a - 2c_1^* - c_2}{4b}$$

and

$$P = \frac{a + 2c_1^* + c_2}{4}$$

Substituting in the welfare function, the result is:

$$W^L = \frac{(a - 2c_1^* + c_2)^2}{8b}$$

A.2 Welfare Comparison $\delta = 1$

$$W^L - W^D = \frac{(a - 2c_1^* + c_2)^2}{8b} - \frac{[n(a + c_2) - 2\sum_{i=1}^n c_{1i}]^2 + 8n[n\sum_{i=1}^n (c_{1i})^2 - (\sum_{i=1}^n c_{1i})^2]}{8bn^2}$$

\Rightarrow

$$W^L - W^D = \frac{c_1^{*2}n^2 + n(a + c_2)[\sum_{i=1}^n c_{1i} - nc_1^*] + 2n(\sum_{i=1}^n c_{1i})^2 - [(\sum_{i=1}^n c_{1i})^2 + 2n^2\sum_{i=1}^n (c_{1i})^2]}{8bn^2}$$

The sufficient condition for the difference of the two welfare functions to be positive and therefore for the lobbying contest intervention to be welfare enhancing is given by the following expression:

$$(a + c_2) > \frac{2n^2\sum_{i=1}^n (c_{1i})^2 - (2n - 1)(\sum_{i=1}^n c_{1i})^2 - c_1^{*2}n^2}{n[\sum_{i=1}^n c_{1i} - nc_1^*]}$$

Therefore, for the lobbying contest intervention to be welfare improving, the sum of the parameters capturing the market size and the cost of the foreign rival must exceed a certain threshold. The analysis of this threshold is complex when all the above variables are

involved, so we shall endeavour to use a simplified example for its examination. Therefore for the case of $n = 2$, where the costs of two firms operating in the market are given by c_1^* for the low cost firm and \hat{c}_1 for the high cost,

$$a + c_2 > \frac{4c_1^{*2} + 13\hat{c}_1^2}{3(\hat{c}_1 - 2c_1^*)}$$

Note that the denominator is positive as $\sum_{i=1}^n c_{1i} > nc_1^*$, therefore the conclusion we come to is that, this threshold increases as the level of the operating cost of the two firms in the market increases. The effect of the high cost firm is greater than that of the low cost firm, hence if the cost differential is high the threshold increases.

For the case of $n = 3$, where the costs of two firms operating in the market are given by c_1^* for the low cost firm and \hat{c}_1, \check{c}_1 , for the high cost firms, where $\hat{c}_1 < \check{c}_1$ the threshold value takes the form:

$$a + c_2 > \frac{(\check{c}_1 + \hat{c}_1 - 2c_1^*)^2 + 12\check{c}_1(\check{c}_1 - \hat{c}_1) + 6\hat{c}_1(\hat{c}_1 - c_1^*) + 6(\hat{c}_1^2 - \check{c}_1c_1^*)}{3(\check{c}_1 + \hat{c}_1 - 2c_1^*)}$$

The same applies to this example, the threshold increases with the country 1 cost values, therefore the market size and the cost advantage required for the welfare improvement also increase.

Therefore the lobbying contest is welfare improving when the market size served is high and the cost advantage of the national champion exceeds a certain value, which increases with the number of oligopolistic firms operating in the market under the a'la Dixit model.

A.3 Welfare Levels $\delta > 1$

A'la Dixit Oligopoly (with cost asymmetry)

For the case described by the Dixit model, with cost asymmetry, when $\delta > 1$, the production stage of the game, where firms set their output, is not directly affected by the relaxation of the pure transfer assumption, therefore the analysis of stage two is similar to the corresponding analysis of Appendix 1. The firms, as mentioned above differ in their production costs, so we have $c_{11} \geq c_{12} \geq \dots \geq c_{1n}$. Therefore the following expressions for the output levels for country 2 and country 1 are obtained:

$$X_2 = \frac{a - ns + \sum_{i=1}^n c_{1i} - (n+1)c_2}{(n+2)b}$$

and

$$X^D = \frac{na + 2ns - 2\sum_{i=1}^n c_{1i} + nc_2}{(n+2)b}$$

Then the total output level exported to the third country and the inverse demand function are given respectively by:

$$Q^D = X^D + X_2 = \frac{(n+1)a + ns - \sum_{i=1}^n c_{1i} - c_2}{(n+2)b}$$

and

$$P(Q^D) = \frac{a - ns + \sum_{i=1}^n c_{1i} + c_2}{(n+2)}$$

In order to set that optimal subsidisation level, the government maximises its objective function, given by the domestic welfare level. Then:

$$W^D = P(Q)X^D - \sum_{i=1}^n (c_{1i}X_{1i}) + (1-\delta)sX^D$$

where the total cost level $\sum_{i=1}^n (c_{1i} X_{1i})$ is obtained through the following:

$$\sum_{i=1}^n c_{1i} X_{1i} = \frac{a \sum_{i=1}^n c_{1i} + c_2 \sum_{i=1}^n c_{1i} + (\sum_{i=1}^n c_{1i})^2 - (n+2) \sum_{i=1}^n (c_{1i})^2 + 2s \sum_{i=1}^n c_{1i}}{(n+2)b}$$

Maximising with respect to the subsidy level and solving for the optimal protectionist measure ($\frac{dW}{ds} = 0$) leads to the following result:

$$s = - \frac{((n+2)\delta - 4)(na + nc_2 - 2 \sum_{i=1}^n c_{1i})}{4n((n+2)\delta - 2)}$$

Note that the non negativity constraint here requires that for positive production by the lowest cost firm:

$$\begin{aligned} s &> - \frac{a + c_2 - (n+2)c_1^* + \sum_{i=1}^n c_{1i}}{2} \\ \Rightarrow - \frac{((n+2)\delta - 4)(na + nc_2 - 2 \sum_{i=1}^n c_{1i})}{4n((n+2)\delta - 2)} &> - \frac{a + c_2 - (n+2)c_1^* + \sum_{i=1}^n c_{1i}}{2} \end{aligned}$$

This expression reduces to

$$\begin{aligned} &2(\delta n^2 a - 4 \sum_{i=1}^n c_{1i}) + 4(\delta n a - 2 \sum_{i=1}^n c_{1i}) + 8n \sum_{i=1}^n c_{1i}(\delta - 1) + \\ &2\delta n^2(c_2 - 4c_1^*) + 4\delta(c_2 - 4c_1^*) + 8\delta n(\sum_{i=1}^n c_{1i} - nc_1^*) + 8n(n+2) \\ &> 0 \end{aligned}$$

For the first two terms, by assumption $a > \sum_{i=1}^n c_{1i}$. Thus, for a oligopoly to exist $n \geq 2 \Rightarrow n^2 a > 4 \sum_{i=1}^n c_{1i}$. Also, $c_2 > 4c_1^*$ this is true since by assumption $c_2 > 2nc_1^*$ and $n \geq 2$. Therefore the lowest cost firm will be producing a positive output. The same principle applies for total production, where the condition becomes:

$$(n+2)\delta > 0$$

This again is positive, thus the total production in the oligopolistic situation is positive.

Then, by substituting in the production level expression from above, we obtain the following:

$$X^D = \frac{\delta(an + c_2n - 2\sum_{i=1}^n c_{1i})}{2((2+n)\delta - 2)b}$$

and the inverse demand function:

$$P = \frac{(a + c_2)((4+n)\delta - 4) + 2\delta(\sum_{i=1}^n c_{1i})}{((2+n)4\delta - 8)}$$

Therefore the welfare level is given by:

$$W^D = \frac{\delta^2[n(a + c_2) - 2\sum_{i=1}^n c_{1i}]^2 + 4[2\delta(n+2) - 4][n\sum_{i=1}^n (c_{1i})^2 - (\sum_{i=1}^n c_{1i})^2]}{8b[(n+2)\delta - 2]}$$

Lobbying Contest

Turning to the derivation of the welfare function in the case where the lobbying contest leads to the elimination of the $(n-1)$ inefficient firms in the market through the contest. Then, again, the second stage is not affected by $\delta > 1$, therefore, using the analysis of appendix 1 for the lobbying contest under $\delta > 1$ the optimal production level is given by:

Maximising and solving as previously, we obtain:

$$X_1^* = \frac{a - 2c_1^* + c_2 + 2s_1^*}{3b}$$

and

$$X_2 = \frac{a - 2c_2 + c_1^* - s_1^*}{3b}$$

Then, as in the previous section, we maximise the domestic welfare function (equation 1.42) above with respect to the subsidy, and obtain the optimal level of this policy

measure.

$$s_1^* = \frac{(a - 2c_1^* + c_2)(3\delta - 4)}{(8 - 12\delta)}$$

Note that the existence of a cost associated with the transfer of funds towards the monopoly implies that this measure is negative. It could however, be more optimal for the low cost firm as the effect of this tax would be less than the uniform measure's.

By substituting where required, we obtain:

$$X^L = X_1^* = \frac{(a - 2c_1^* + c_2)\delta}{2b(3\delta - 2)}$$

and

$$P = \frac{(a + c_2)(5\delta - 4) + 2\delta c_1^*}{(12\delta - 8)}$$

Substituting in the welfare function, the result is:

$$W^L = \frac{\delta^2(a - 2c_1^* + c_2)^2}{(3\delta - 2)8b}$$

A.4 Welfare Comparison $\delta > 1$

$$W^L - W^D =$$

$$\frac{\delta^2(a - 2c_1^* + c_2)^2}{(3\delta - 2)8b} - \frac{\delta^2[n(a + c_2) - 2\sum_{i=1}^n c_{1i}]^2 + 4[2\delta(n + 2) - 4][n\sum_{i=1}^n (c_{1i})^2 - (\sum_{i=1}^n c_{1i})^2]}{8b[(n + 2)\delta - 2]}$$

\Rightarrow Denoting $(3\delta - 2) = A$ and $[(n + 2)\delta - 2] = B$, the expression in a more simplified form becomes:

$$\begin{aligned}
 W^L - W^D &= \\
 &= \frac{\delta^2 a(a + 4(c_2 - 2c_1^*))}{8Ab} + \frac{\delta^2 c_1^{*2}}{2Ab} + \frac{\delta^2 c_2(c_2 - 4c_1^*)}{2Ab} \\
 &\quad + \frac{[2\delta(n + 1) - 2](\sum_{i=1}^n c_{1i})^2}{bnB} + \frac{[2(\delta - 1)]\sum_{i=1}^n (c_{1i})^2}{bB} \\
 &\quad + \frac{\delta^2(\sum_{i=1}^n c_{1i})(an - \sum_{i=1}^n c_{1i})}{2bnB} - \frac{a^2\delta^2 n}{8bnB} - \frac{\delta n \sum_{i=1}^n (c_{1i})^2}{bB} \\
 &\quad - \frac{\delta^2 c_2[n(2a + c_2) - 4\sum_{i=1}^n c_{1i}]}{8bB}
 \end{aligned}$$

The above expression contains both positive and negative terms. The negative will be compared to the positive, in order to derive the sufficient conditions for welfare increase through the intervention.

Therefore, comparing:

$$\frac{\delta^2 a(a + 4(c_2 - 2c_1^*))}{8Ab} \text{ to } -\frac{a^2\delta^2 n}{8bnB}$$

\Rightarrow

$$\begin{aligned}
 &\frac{\delta^2 a(a + 4(c_2 - 2c_1^*))}{8Ab} - \frac{a^2\delta^2 n}{8bnB} \\
 &= \frac{\delta^2 a^2 n(n - 1)\delta + 4\delta^2 an(c_2 - 2c_1)}{8ABnb} > 0
 \end{aligned}$$

The above expression is always positive, as by assumption $c_2 > 2nc_1$.

Then comparing:

$$\frac{\delta^3 a^2 n(n - 1) + 4\delta^2 an(c_2 - 2c_1)}{8ABnb} \text{ to } -\frac{\delta^2 c_2[n(2a + c_2) - 4\sum_{i=1}^n c_{1i}]}{8bB}$$

\Rightarrow

$$\begin{aligned} & \frac{\delta^2 c_2 (c_2 - 4c_1^*)}{2Ab} - \frac{\delta^2 c_2 [n(2a + c_2) - 4 \sum_{i=1}^n c_{1i}]}{8bB} \\ &= \frac{\delta^3 an[a(n-1) - 6c_2] + 8\delta^2 an(c_2 - c_1) + (3\delta - 2)\delta^2 c_2 [4 \sum_{i=1}^n c_{1i} - nc_2]}{8bBA} \end{aligned}$$

The sufficient conditions for this expression to be positive are given by:

$$c_2 < \frac{4 \sum_{i=1}^n c_{1i}}{n}$$

and

$$c_2 < \frac{(n-1)a}{6}$$

Finally, comparing

$$\frac{[2\delta(n+1) - 2](\sum_{i=1}^n c_{1i})^2}{bnB} \text{ to } - \frac{\delta n \sum_{i=1}^n (c_{1i})^2}{bB}$$

The sufficient condition for this expression to be positive is given by:

$$\frac{(\sum_{i=1}^n c_{1i})^2}{\sum_{i=1}^n (c_{1i})^2} > \frac{\delta n}{[2\delta(n+1) - 2]}$$

Therefore, the intervention is welfare improving when the sufficient conditions hold.

Appendix B

Appendix for Chapter 2

B.1 Proposition 6 & Proposition 7 Proof

The Lagrangian for the joint welfare maximisation problem, where the objective function is given by:

$$W^J = W_1^J + W_2^J = \zeta[U(Q^J) - PQ^J] + \Pi_1^J - s_1^J Q_1^J + \gamma[U(Q^J) - PQ^J] + \Pi_2^J - s_2^J Q_2^J$$

takes the form

$$L = W^J + \mu_1(Q_1^J - 0) + \mu_2(Q_2^J - 0)$$

Note that the non negativity constraints included in the Lagrangian ensure that at the potential corner solutions, one firm produces zero levels of output, however the remaining firm will be receiving such measures leading to production that maximizes consumers' surplus, but not above.

Differentiating firstly with respect to the policy measure set by country one and then country two, the following FOCs are derived:

$$\frac{dL}{ds_1^J} = \frac{dW^J}{ds_1^J} + \mu_1 \frac{dQ_1^J}{ds_1^J} + \mu_2 \frac{dQ_2^J}{ds_1^J} = 0$$

$$\frac{dL}{ds_2^J} = \frac{dW^J}{ds_2^J} + \mu_1 \frac{dQ_1^J}{ds_2^J} + \mu_2 \frac{dQ_2^J}{ds_2^J} = 0$$

Optimality conditions

$$\mu_1 \left(\frac{a - 2c_1 + 2s_1^J + c_2 - s_2^J}{3b} \right) = 0 \text{ Complementarity}$$

$$\mu_2 \left(\frac{a - 2c_2 + 2s_2^J + c_1 - s_1^J}{3b} \right) = 0 \text{ Complementarity}$$

$$\frac{a - 2c_1 + 2s_1^J + c_2 - s_2^J}{3b} \geq 0$$

$$\frac{a - 2c_2 + 2s_2^J + c_1 - s_1^J}{3b} \geq 0$$

$$\mu_1 \geq 0$$

$$\mu_2 \geq 0$$

Since we have two complementarity conditions, there are four cases to be examined:

Case 1

$$\mu_1 = \mu_2 = 0 \Rightarrow$$

$$s_1^J = \frac{[2(\gamma + \zeta) - 1]a - (\gamma + \zeta + 4)c_1 - (\gamma + \zeta - 5)c_2 + (\gamma + \zeta - 2)s_2^J}{(2 - \gamma - \zeta)}$$

and

$$s_1^J = \frac{[2(\gamma + \zeta) - 1]a - (\gamma + \zeta + 4)c_2 - (\gamma + \zeta - 5)c_1 + (\gamma + \zeta - 2)s_1^J}{(2 - \gamma - \zeta)}$$

These policy measures do not constitute a solution, as they lead to an inconsistent system.²³

Case 2

$$\mu_1 = 0 \text{ and } a - 2c_2 + 2s_2^J + c_1 = s_1^J \Rightarrow$$

$$s_2^J = \frac{9(\gamma + \zeta - 1)a - 7c_1 + [9(\gamma + \zeta) + 14]c_2}{7(\gamma + \zeta - 2)}$$

$$s_1^J = \frac{[25(\gamma + \zeta) - 32]a + [7(\gamma + \zeta) - 28]c + [4(\gamma + \zeta) + 56]c_2}{7(\gamma + \zeta - 2)}$$

and

$$\mu_2 = \frac{[48(\gamma + \zeta - 1)]a - 53c_1 + [8(\gamma + \zeta) - 21]c_2}{21} < 0$$

²³ If solved simultaneously, these lead to $c_1 = c_2$, not feasible by assumption.

As $\mu_2 < 0$, the above policy measures do not constitute a solution.

Case 3

$$\mu_2 = 0 \text{ and } a - 2c_1 + 2s_1^J + c_2 = s_2^J \implies$$

$$s_1^J = \frac{(1 - \gamma - \zeta)a + c_2 + (\gamma + \zeta - 2)c_1}{\gamma + \zeta - 2} < 0$$

$$s_2^J = \frac{-(\gamma + \zeta)a + (\gamma + \zeta)c_2}{\gamma + \zeta - 2} > 0$$

and

$$\mu_1 = 6(c_2 - c_1) > 0$$

This constitutes a solution to the maximisation problem.

Case 4

$$a - 2c_2 + 2s_2^J + c_1 = s_1^J \text{ and } a - 2c_1 + 2s_1^J + c_2 = s_2^J \implies$$

$$s_1^J = -(a - c_1) < 0$$

$$\mu_1 = -(a - c_1) < 0$$

and

$$\mu_2 = -(a - c_2) < 0$$

This therefore does not constitute a solution to the maximisation problem .

Concluding the analysis, the only solution to the system is obtained in *case 3*, and the profits corresponding to the particular policy measures are given by:

$$\Pi_1^J = 0$$

$$\Pi_2^J = \frac{(a - c_2)^2}{(2 - \gamma - \zeta)^2 b}$$

and therefore total profits equal:

$$\Pi^J = \Pi_1^J + \Pi_2^J = 0 + \frac{(a - c_2)^2}{(2 - \gamma - \zeta)^2 b}$$

For the welfare levels, total consumers' welfare is given by:

$$CS^J = \frac{(a - c_2)^2}{2(2 - \gamma - \zeta)^2 b}$$

and so the welfare levels are given by:

$$W_1^J = \zeta \frac{(a - c_2)^2}{2(2 - \gamma - \zeta)^2 b}$$

and

$$W_2^J = \gamma \frac{(a - c_2)^2}{2(2 - \gamma - \zeta)^2 b} + \frac{(a - c_2)^2}{(2 - \gamma - \zeta)^2 b} - \frac{(\gamma + \zeta)((a - c_2)^2)}{(2 - \gamma - \zeta)^2 b}$$

Therefore total welfare is given by:

$$W^J = W_1^J + W_2^J = \frac{(a - c_2)^2}{(2 - \gamma - \zeta)^2 b} - \frac{(\gamma + \zeta)((a - c_2)^2)}{2(2 - \gamma - \zeta)^2 b}$$

B.2 Proposition 8 Proof

Note that for a duopoly to exist and serve the markets in the non cooperative case, the following constraint must hold: $(\zeta - \gamma + 1)a - (3 - \gamma)c_1 + (2 - \zeta)c_2 > 0$. This is determined by the value of parameters ζ, γ and so for each case we examine whether the constraint holds. In this way the non cooperational profits are determined, so a comparison to the co-operational levels can take place.

Case 1: $\zeta = 0, \gamma = 0$ and the constraint becomes: $a - 3c_1 + 2c_2 > 0$, implying that both firms are able to produce positive amounts.

$$\begin{aligned}\Pi^{NC} &= \frac{8(a - c_2)^2 + 52(c_1 - c_2)^2 - 8(a - c_2)(c_1 - c_2)}{25b} \\ \Pi^{Jc} &= \frac{(a - c_2)^2}{4b} \\ \Pi^c &= \frac{(a - c_2)^2}{16b} \\ \Pi^J &= \frac{(a - c_2)^2}{4b}\end{aligned}$$

It is obvious from the above equations that $\Pi^{Jc} = \Pi^J > \Pi^c$

Denoting $x = (a - c_2)$ and $y = (c_1 - c_2)$, then for $\Pi^{NC} > \Pi^J$, the following is required:

$$\begin{aligned}\frac{8(a - c_2)^2 + 52(c_1 - c_2)^2 - 8(a - c_2)(c_1 - c_2)}{25b} - \frac{(a - c_2)^2}{4b} &> 0 \\ \frac{8x^2 + 52y^2 - 8xy}{25b} - \frac{x^2}{4b} &> 0\end{aligned}$$

\Rightarrow

$$\frac{32x^2 + 208y^2 - 32xy - 25x^2}{100b} > 0$$

\Rightarrow

$$\frac{(2x - 8y)^2 + 3x^2 + 144y^2}{100b} > 0$$

which always holds, therefore the ranking for this case is given by:

$$\Pi^{NC} > \Pi^{Jc} = \Pi^J > \Pi^c$$

Case 2: $\zeta = 0, \gamma = 1$ and the constraint becomes: $2(a - c_1 + c_2) > 0$, therefore the constraint is binding. Thus the profits are given by:

$$\Pi^{NC} = \frac{4(a - c_2)^2 + 5(c_1 - c_2)^2 + 4(a - c_2)(c_1 - c_2)}{4b}$$

$$\begin{aligned}\Pi^{Jc} &= \frac{(a - c_2)^2}{b} \\ \Pi^c &= \frac{(a - c_2)^2}{9b} \\ \Pi^J &= \frac{(a - c_2)^2}{b}\end{aligned}$$

It is obvious from the above equations that the ranking for this case is given by:

$$\Pi^{Jc} = \Pi^J > \Pi^c$$

For the non cooperative profits to be greater than the Jc situation, the difference between the two profit levels must be positive:

$$\begin{aligned}\Pi^{NC} - \Pi^{Jc} &> 0 \\ \Rightarrow \frac{4(a - c_2)^2 + 5(c_1 - c_2)^2 + 4(a - c_2)(c_1 - c_2)}{4b} - \frac{(a - c_2)^2}{b} &> 0 \\ \Rightarrow \frac{5(c_1 - c_2)^2 + 4(a - c_2)(c_1 - c_2)}{4b} &> 0\end{aligned}$$

which is true, therefore the ranking takes the form

$$\Pi^{NC} > \Pi^{Jc} = \Pi^J > \Pi^c$$

Case 3: $\zeta = 1, \gamma = 0$ and the constraint becomes: $-3c_1 + c_2 = -(3c_1 - c_2) < 0$, implying that the constraint does not hold, and thus the firm in country 2 becomes the monopolist, serving all markets. Hence the profit levels are given by:

$$\begin{aligned}\Pi^{NC} &= \frac{(a - c_2)^2}{b} \\ \Pi^{Jc} &= \frac{(a - c_2)^2}{b} \\ \Pi^c &= \frac{(a - c_2)^2}{9b} \\ \Pi^J &= \frac{(a - c_2)^2}{b}\end{aligned}$$

It is obvious from the above equations that

$$\Pi^{Jc} = \Pi^J = \Pi^{NC} > \Pi^c$$

B.3 Proposition 9 Proof

Turning to the welfare levels, the constraints take the same form as in Appendix B.2, when the levels of the consumption parameters vary. Note that for the duopoly to exist and serve the markets in the non cooperative case, the following constraint must also hold: $(\zeta - \gamma + 1)a - (3 - \gamma)c_1 + (2 - \zeta)c_2 > 0$. Therefore this constraint is also taken into consideration when each of the case is examined. Hence:

Case 1: $\zeta = 0, \gamma = 0$ and the constraint becomes: $a - 3c_1 + 2c_2 > 0$, implying that both firms are able to produce positive amounts. The welfare levels are defined as:

$$\begin{aligned} W^{NC} &= \frac{4(a - c_2)^2 + 8(c_1 - c_2)^2}{25b} \\ W^{Jc} &= \frac{(a - c_2)^2}{4b} \\ W^c &= \frac{3(a - c_2)^2}{16b} \\ W^J &= \frac{(a - c_2)^2}{4b} \end{aligned}$$

It is obvious from the above equations that $W^{Jc} = W^J > W^c$

Denoting $x = (a - c_2)$ and $y = (c_1 - c_2)$, then for $W^{NC} > W^J$, the following is required: $W^{NC} - W^J > 0$

$$\begin{aligned} &\frac{4(a - c_2)^2 + 3(c_1 - c_2)^2}{25b} - \frac{(a - c_2)^2}{4b} \\ &= \frac{-9x^2 + 3y^2}{100b} < 0 \end{aligned}$$

Based on the assumptions $a > c_1$, $a > c_2$ and $c_1 > c_2$, the difference between these values is negative and therefore, $W^{NC} < W^J$. We, at this point, are required to compare W^{NC} to W^c . Therefore, for $W^{NC} > W^c$ we require that $W^{NC} - W^c > 0$

$$\begin{aligned} & \frac{4(a - c_2)^2 + 3(c_1 - c_2)^2}{25b} - \frac{3(a - c_2)^2}{16b} \\ = & \frac{-11x^2 + 3y^2}{400b} < 0 \end{aligned}$$

Once more, based on the above mentioned assumptions, the difference $W^{NC} - W^c$ is negative, therefore the overall ranking is given by:

$$W^{Jc} = W^J > W^c > W^{NC}$$

Case 2: $\zeta = 0, \gamma = 1$ and the constraint becomes: $2(a - c_1 + c_2) > 0$, implying that both firms are able to produce positive amounts. The welfare levels are defined as:

$$\begin{aligned} W^{NC} &= \frac{4(a - c_2)^2 + 3(c_1 - c_2)^2}{25b} \\ W^{Jc} &= \frac{(a - c_2)^2}{2b} \\ W^c &= \frac{5(a - c_2)^2}{18b} \\ W^J &= \frac{(a - c_2)^2}{2b} \end{aligned}$$

It is obvious from the above equations that $W^{Jc} = W^J > W^c$

Denoting $x = (a - c_2)$ and $y = (c_1 - c_2)$, then for $W^{NC} > W^J$, the following is required: $W^{NC} - W^J > 0$

$$\begin{aligned} & \frac{4x^2 + 3y^2}{25b} - \frac{x^2}{2b} \\ = & \frac{-17x^2 + 6y^2}{50b} < 0 \end{aligned}$$

Based on the assumptions $a > c_1$, $a > c_2$ and $c_1 > c_2$, the difference between these values is negative and therefore, $W^{NC} < W^J$. We, at this point, are required to compare W^{NC} to W^c . Therefore, for $W^{NC} > W^c$ we require that $W^{NC} - W^c > 0$

$$\begin{aligned} & \frac{4x^2 + 3y^2}{25b} - \frac{5x^2}{18b} \\ &= \frac{-50x^2 + 54y^2}{450b} < 0 \end{aligned}$$

Once more, based on the above mentioned assumptions, the difference $W^{NC} - W^c$ is negative, therefore the overall ranking is given by:

$$W^{Jc} = W^J > W^c > W^{NC}$$

Case 3: $\zeta = 1, \gamma = 0$ and the constraint becomes: $-(3c_1 - c_2) < 0$, implying that firm 1 is the monopolist in the market. The welfare levels are defined as:

$$\begin{aligned} W^{NC} &= \frac{(a - c_2)^2}{2b} \\ W^{Jc} &= \frac{(a - c_2)^2}{2b} \\ W^c &= \frac{5(a - c_2)^2}{18b} \\ W^J &= \frac{(a - c_2)^2}{2b} \end{aligned}$$

It is obvious from the above equations that

$$W^{Jc} = W^J = W^{NC} > W^c$$

B.4 Proposition 10 Proof

The Lagrangian for the joint welfare maximisation problem, where the objective function is given by:

$$W^J = W_1^J + W_2^J = \Pi_1^J - s_1^J Q_1^J + \Pi_2^J - s_2^J Q_2^J$$

takes the form:

$$L = W^J + \mu_1(Q_1^J - 0) + \mu_2(Q_2^J - 0)$$

Differentiating firstly with respect to the policy measure set by country one and then country two, the following FOCs are derived:

$$\frac{dL}{ds_1^J} = \frac{dW^J}{ds_1^J} + \mu_1 \frac{dQ_1^J}{ds_1^J} + \mu_2 \frac{dQ_2^J}{ds_1^J} = 0$$

$$\frac{dL}{ds_2^J} = \frac{dW^J}{ds_2^J} + \mu_1 \frac{dQ_1^J}{ds_2^J} + \mu_2 \frac{dQ_2^J}{ds_2^J} = 0$$

Optimality Conditions

$$\mu_1 \left(\frac{a(b + d_2) + d_2(s_1^J - c_1) + b(-2c_1 + c_2 + 2s_1^J - s_2^J)}{3b^2 + d_1d_2 + 2b(d_1 + d_2)} \right) = 0 \text{ Complementarity}$$

$$\mu_2 \left(\frac{a(b + d_1) + d_1(s_2^J - c_2) + b(-2c_2 + c_1 + 2s_2^J - s_1^J)}{3b^2 + d_1d_2 + 2b(d_1 + d_2)} \right) = 0 \text{ Complementarity}$$

$$\left(\frac{a(b + d_2) + d_2(s_1^J - c_1) + b(-2c_1 + c_2 + 2s_1^J - s_2^J)}{3b^2 + d_1d_2 + 2b(d_1 + d_2)} \right) \geq 0$$

$$\left(\frac{a(b + d_1) + d_1(s_2^J - c_2) + b(-2c_2 + c_1 + 2s_2^J - s_1^J)}{3b^2 + d_1d_2 + 2b(d_1 + d_2)} \right) \geq 0$$

$$\mu_1 \geq 0$$

$$\mu_2 \geq 0$$

Since we have two complementarity conditions, there are four cases to be examined:

Case 1

$$\mu_1 = \mu_2 = 0 \implies$$

$$s_1^J = \frac{b(2b(c_1 - c_2) + d_1(a - c_2))}{2b(d_1 + d_2) + d_1d_2}$$

and

$$s_2^J = \frac{b(2b(c_2 - c_1) + d_2(a - c_1))}{2b(d_1 + d_2) + d_1d_2}$$

These policy measures lead to the following levels of profits and welfare:

$$\Pi_1^J = \frac{(2b + d_1)[2b(c_1 - c_2) - d_2(a - c_1)]^2}{(2b(d_1 + d_2) + d_1d_2)^2}$$

$$\Pi_2^J = \frac{(2b + d_2)[2b(c_1 - c_2) - d_1(a - c_2)]^2}{(2b(d_1 + d_2) + d_1d_2)^2}$$

$$W_1^J = \frac{(a - c_1)[2b(c_1 - c_2) + d_2(a - c_1)]}{(4b(d_1 + d_2) + d_1d_2)}$$

$$W_2^J = \frac{(a - c_2)[2b(c_1 - c_2) + d_1(a - c_2)]}{(4b(d_1 + d_2) + d_1d_2)}$$

For the solution in case 1, there is a requirement to analyse the Second Order conditions, which in this maximisation problem need to be negative. Therefore:

$$\frac{d^2L}{d^2s_1^J} = \frac{-2b^3 + b(-4d_1 - 5d_2) - (d_1)^2d_2 - 2bd_2(2d_1 + d_2)}{(3b^2 + d_1d_2 + 2b(d_1 + d_2))^2}$$

$$\frac{d^2L}{d^2s_2^J} = \frac{-2b^3 + b(-4d_2 - 5d_1) - (d_2)^2d_1 - 2bd_1(2d_2 + d_1)}{(3b^2 + d_1d_2 + 2b(d_1 + d_2))^2}$$

These SOC's are negative for very small values of the elasticity b , however for higher values, the sign of these expressions becomes positive and therefore this solution is not sustainable.

Case 2

$$\mu_1 = 0 \text{ and } s_1^J = \frac{a(b+d_1)+d_1(s_2-c_2)+b(c_1-2c_2+2s_2)}{b} \implies$$

$$s_2^J = \frac{-bc_1 + 2bc_2 + c_2d_1 - a(b + d_1)}{2b + d_1}$$

$$s_1^J = 0$$

and

$$\mu_2 = \frac{-2b(c_1 - c_2) - d_1(a - c_2)}{2b + d_1}$$

The corresponding output, profit and welfare levels in case 2 are given by the following functions:

$$Q_1^J = \frac{a - c_1}{2b + d_1} \text{ and } Q_2^J = 0$$

$$\Pi_1^J = \frac{(a - c_1)^2}{2(2b + d_1)} \text{ and } \Pi_2^J = 0$$

\implies

$$\Pi^J = \frac{(a - c_1)^2}{2(2b + d_1)}$$

$$W^J = \frac{(a - c_1)^2}{2(2b + d_1)}$$

Case 3

$$\mu_2 = 0 \text{ and } s_2^J = \frac{a(b+d_2)+d_2(s_1-c_1)+b(c_2-2c_1+2s_1^J)}{b} \implies$$

$$s_1^J = 0$$

$$s_2^J = \frac{-bc_2 + 2bc_1 + c_1d_2 - a(b + d_2)}{2b + d_2}$$

and

$$\mu_1 = \frac{2b(c_1 - c_2) + d_2(a - c_1)}{2b + d_2}$$

The corresponding output, profit and welfare levels in case 3 are given by the following functions:

$$Q_1^J = 0 \text{ and } Q_2^J = \frac{a - c_2}{2b + d_2}$$

$$\Pi_1^J = 0 \text{ and } \Pi_2^J = \frac{(a - c_2)^2}{2(2b + d_2)}$$

\Rightarrow

$$\Pi^J = \frac{(a - c_2)^2}{2(2b + d_2)}$$

$$W^J = \frac{(a - c_2)^2}{2(2b + d_2)}$$

Case 4

$$s_1^J = -(a - c_1) \text{ and } s_2^J = -(a - c_2) \Rightarrow$$

$$\mu_1 = -(a - c_1) < 0$$

and

$$\mu_2 = -(a - c_2) < 0$$

This therefore does not constitute a solution to the maximisation problem .

The two corner solutions are given by cases 2 and 3. The observation for these two solutions is that they involve one of the two producing firms becoming the monopolist, when the other firm produces nothing. Essentially, the sign of variables μ_1 and μ_2 will determine the solution, and thus the monopolist arising. For the solutions derived to hold, both these under the optimality conditions are required to be positive. Hence:

$$\mu_1 = \frac{2b(c_1 - c_2) - d_2(a - c_1)}{2b + d_2}$$

$$\mu_2 = \frac{-2b(c_1 - c_2) - d_1(a - c_2)}{2b + d_1}$$

Note that for these two solutions the requirements are the following:

In order for the case 2 results to constitute a solution, it is required that $\mu_1 = 0$ and

$$\mu_2 > 0 \Rightarrow \frac{-2b(c_1 - c_2) - d_1(a - c_2)}{2b + d_1} > 0$$

In order for the case 3 results to constitute a solution, it is required that $\mu_2 = 0$ and

$$\mu_1 > 0 \Rightarrow \frac{2b(c_1 - c_2) - d_2(a - c_1)}{2b + d_2} > 0.$$

It is obvious from the above that not both these can be a solution simultaneously, thus, one of the two corner solutions can be the answer to the maximisation problem at a time. What we need to establish is the conditions under which, each of these becomes the solution.

(i) Looking at the condition for the case 2 solution:

$$\mu_2 > 0 \Rightarrow 2b(c_1 - c_2) < -d_1(a - c_2)$$

This condition holds for low values of the cost asymmetry gap $(c_1 - c_2)$, low b , high values of d_1 ($d_1 < -1$) and high values of the difference $(a - c_2)$, hence for a large market, as parameter a captures the market size. For these parameter values, the condition is satisfied, case two is the solution and $\mu_1 = 0$. Note that condition also provides with a threshold value for the market size above which firm 2 will be the monopolist in the market. Thus

$$\mu_2 > 0 \Rightarrow a^J = a > c_2 - \frac{2b(c_1 - c_2)}{d_1}$$

(ii) Under the assumption that $d_1, d_2 < -2$,²⁴ for case 3 to be a solution, where $Q_1^J = 0$ and $Q_2^J > 0$, with firm 2 producing at the one firm monopoly level, the following must hold:

$$\mu_1 > 0 \Rightarrow 2b(c_1 - c_2) > d_2(a - c_1)$$

This condition holds for high values of the cost asymmetry gap ($c_1 - c_2$), high b , low values of d_2 and low values of the difference ($a - c_1$), hence for a small market, as parameter a captures the market size.

Note however that if this condition holds for these values, then the second Lagrange multiplier, μ_2 , is equal to zero.

Therefore, the observation is that for a small market, a high cost asymmetry gap level and a small rate of the marginal cost curve decline for the firm in country 2, the firm in country 2 will undertake all production. The essentially the cost asymmetry gap is great and although the rate of the MC curve decline is small, the overall effect still leaves the firm in country 2 as the cost efficient one, thus this becomes the monopolist. If on the other hand, we have a large market, a small cost gap level and a large rate of marginal cost decline for country 1, the results are reversed and firm 1 undertakes all production.²⁵

²⁴ This assumption regarding the value of the decreasing rate is essential as this ensures that the output is non negative in both the cases where firm 1 is the monopolist or firm 2 is the monopolist.

Note also that the MC for either firm can not be negative, so the following restriction must hold:

$$d_1 < \frac{2bc_1}{a-2c_1} \text{ and } d_2 < \frac{2bc_2}{a-2c_2}$$

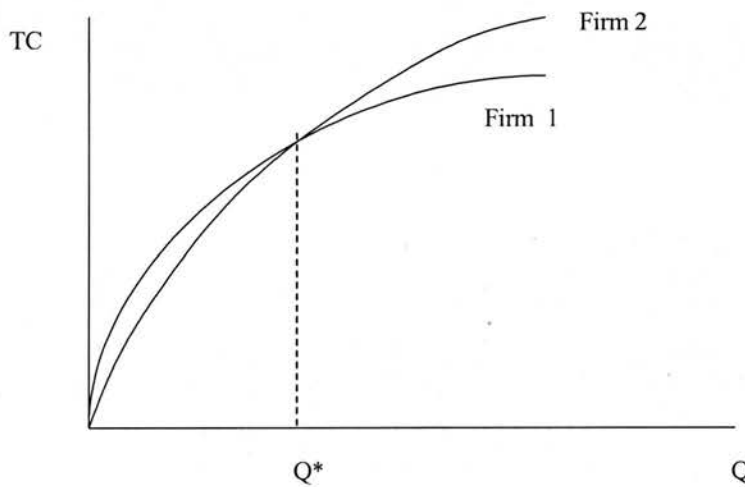
²⁵ Note that for these particular values of the parameters, the non negativity constraints for positive production imposed by firms in stage 2 also hold:

$$\begin{aligned} Q_1^J &\geq 0 \\ \Rightarrow bs_2 - (2b + d_2)s_1 &\geq ab - 2bc_1 + bc_2 + ad_2 - c_1d_2 \end{aligned}$$

$$\begin{aligned} Q_2^J &\geq 0 \\ \Rightarrow bs_1 - (2b + d_1)s_2 &\geq ab - 2bc_2 + bc_1 + ad_1 - c_2d_1 \end{aligned}$$

B.5 Cost Efficiency switch market size

When the two firms make a choice over a coproduction agreement, they need to ensure that the decision over which one will become the monopolist, serving the market is optimal. This is done through the comparison of the cost asymmetry, under the decreasing marginal cost assumption, since, total costs increase at a lower rate for firm 1 compared to firm 2, thus although for low values of output firm 2 maintains the cost efficiency, above a certain threshold, firm 1 becomes the lowest cost firm.



Thus for quantities produced above Q^* , firm 1 produces at a lower cost. We need to define this level of Q^* and then compare that with the monopoly production level of firm 2, to define that market size that makes the choice of firm 1 as the monopolist efficient.

The output level Q^* is given by the intersection of the two average cost curves AC_1 and AC_2 :

$$c_1 + d_1 \frac{Q^*}{2} = c_2 + d_2 \frac{Q^*}{2}$$

\Rightarrow

$$Q^* = \frac{2(c_1 - c_2)}{d_2 - d_1}$$

Note that this level of output is positive for $|d_1| > |d_2|$

(1) For the case of joint welfare maximisation with coproduction, to define the market size a required for firm 1 to be producing, we need to compare this Q^* to Q_1^{Jc} , where Q_1^{Jc} denotes the monopolist output of firm 1. Therefore firm 1 will be the producer in the market if

$$Q_1^{Jc} > Q^* \Rightarrow \frac{a - c_1}{2b + d_1} > 2 \frac{(c_1 - c_2)}{d_2 - d_1}$$

\Rightarrow

$$a^{Jc} = a > c_1 + \frac{2(c_1 - c_2)(2b + d_1)}{d_2 - d_1}$$

(2) For the case of coproduction, to define the market size a required for firm 1 to start producing, we need to compare this Q^* to Q_1^c , where Q_1^c denotes the monopolist output of firm 1. Therefore firm 1 will be the producer in the market if

$$Q_1^c > Q^* \Rightarrow \frac{(a - c_1)}{2(2b + d_1)} > \frac{2(c_1 - c_2)}{d_2 - d_1}$$

\Rightarrow

$$a^c = a > c_1 + \frac{4(c_1 - c_2)(2b + d_1)}{(d_2 - d_1)}$$

Note that

$$a^c > a^{Jc} > a^J$$

Therefore for the case of joint welfare maximisation, a smaller size for the total market is required to switch cost efficiency between firms, compared to the case of coproduction.

B.6 Thresholds and Cooperative Agreement Ranking

Note that this comparison takes place for values $d_1 < d_2$, when firm 1 may prove to be the cost efficient firm in the market, depending on the market size. These critical values for the market size are given by: a^c, a^{Jc}, a^J

For $a > a^c > a^{Jc} > a^J$

	J	c	Jc
Subsidy levels	$s_1^J = 0$ $s_2^J = \frac{-bc_1 + 2bc_2 + c_2d_1 - a(b+d_1)}{2b+d_1}$	$s_1^c = \frac{(a-c_1)(\beta-1)}{2}$ $s_2^c = \frac{-\beta(a-c_1)}{2}$	$s_1^{Jc} + s_2^{Jc} = 0$
Profits	$\Pi^J = \frac{(a-c_1)^2}{2(2b+d_1)}$	$\Pi^c = \frac{(a-c_1)^2}{8(2b+d_1)}$	$\Pi^{Jc} = \frac{(a-c_1)^2}{2(2b+d_1)}$
Welfare	$W^J = \frac{(a-c_1)^2}{2(2b+d_1)}$	$W^c = \frac{3(a-c_1)^2}{8(2b+d_1)}$	$W^{Jc} = \frac{(a-c_1)^2}{2(2b+d_1)}$

The observation in this particular setting is that firm 1 will be the monopolist in all three cooperation agreement regimes and that joint welfare maximisation with and without co-production lead to the same levels of profits and welfare, therefore, $\Pi^J = \Pi^{Jc}$ and $W^J = W^{Jc}$. The full ranking for the profits is given:

$$\Pi^J = \Pi^{Jc} > \Pi^c$$

$$W^J = W^{Jc} > W^c$$

For $a^c > a > a^{Jc} > a^J$

	J	c	Jc
Subsidy levels	$s_1^J = 0$ $s_2^J = \frac{-bc_1 + 2bc_2 + c_2d_1 - a(b+d_1)}{2b+d_1}$	$s_1^c = \frac{(a-c_1)(\beta-1)}{2}$ $s_2^c = \frac{-\beta(a-c_1)}{2}$	$s_1^{Jc} + s_2^{Jc} = 0$
Profits	$\Pi^J = \frac{(a-c_1)^2}{2(2b+d_1)}$	$\Pi^c = \frac{(a-c_1)^2}{8(2b+d_1)}$	$\Pi^{Jc} = \frac{(a-c_2)^2}{2(2b+d_2)}$
Welfare	$W^J = \frac{(a-c_1)^2}{2(2b+d_1)}$	$W^c = \frac{3(a-c_1)^2}{8(2b+d_1)}$	$W^{Jc} = \frac{(a-c_2)^2}{2(2b+d_2)}$

The observation in this case is that firm 2 is the monopolist in the joint welfare maximisation with coproduction and firm two is the monopolist in the coproduction and joint welfare maximisation setting. The ranking will be given by:

Profits

$$\Pi^J > \Pi^c > \Pi^{Jc}$$

or

$$\Pi^J > \Pi^{Jc} > \Pi^c$$

depending on the relative values of d_1 and d_2

Welfare

$$W^J > W^c > W^{Jc}$$

or

$$W^J > W^{Jc} > W^c$$

depending on the relative values of d_1 and d_2 .

For $a^c > a^{Jc} > a > a^J$

	J	c	Jc
Subsidy levels	$s_1^J = 0$ $s_2^J = \frac{-bc_1 + 2bc_2 + c_2d_1 - a(b+d_1)}{2b+d_1}$	$s_1^c = \frac{(a-c_2)(\beta-1)}{2}$ $s_2^c = \frac{-\beta(a-c_2)}{2}$	$s_1^{Jc} + s_2^{Jc} = 0$
Profits	$\Pi^J = \frac{(a-c_1)^2}{2(2b+d_1)}$	$\Pi^c = \frac{(a-c_2)^2}{8(2b+d_2)}$	$\Pi^{Jc} = \frac{(a-c_2)^2}{2(2b+d_2)}$
Welfare	$W^J = \frac{(a-c_1)^2}{2(2b+d_1)}$	$W^c = \frac{3(a-c_2)^2}{8(2b+d_2)}$	$W^{Jc} = \frac{(a-c_2)^2}{2(2b+d_2)}$

In this setting, firm 2 becomes the monopolist for the coproduction and joint welfare maximisation co-operational regimes and firm 1 is the monopolist for the joint welfare maximisation case and the ranking for profits and welfare is given by:

Profits

$$\Pi^J > \Pi^{Jc} > \Pi^c$$

Welfare

$$W^J > W^{Jc} > W^c$$

For $a^c > a^{Jc} > a^J > a$

	J	c	Jc
Subsidy levels	$s_1^J = \frac{-bc_2 + 2bc_1 + c_1d_2 - a(b+d_2)}{2b+d_2}$ $s_2^J = 0$	$s_1^c = \frac{(a-c_2)(\beta-1)}{2}$ $s_2^c = \frac{-\beta(a-c_2)}{2}$	$s_1^{Jc} + s_2^{Jc} = 0$
Profits	$\Pi^J = \frac{(a-c_2)^2}{2(2b+d_2)}$	$\Pi^c = \frac{(a-c_2)^2}{8(2b+d_2)}$	$\Pi^{Jc} = \frac{(a-c_2)^2}{2(2b+d_2)}$
Welfare	$W^J = \frac{(a-c_2)^2}{2(2b+d_2)}$	$W^c = \frac{3(a-c_2)^2}{8(2b+d_2)}$	$W^{Jc} = \frac{(a-c_2)^2}{2(2b+d_2)}$

The observation in this particular setting is that firm 2 will be the monopolist in all three cooperation agreement regimes and the joint welfare maximisation with and without co-production lead to the same levels of profits and welfare, therefore, $\Pi^J = \Pi^{Jc}$ and $W^J = W^{Jc}$. The full ranking for the profits is given:

$$\Pi^J = \Pi^{Jc} > \Pi^c$$

$$W^J = W^{Jc} > W^c$$

B.7 Proposition 14 Proof

The comparison of the cooperative and the non cooperative profit and welfare levels as described by equations 2.110-2.111 is complicated due to the existence of a large number of variables. We set $c_1 = c_2 + \varepsilon$, due to the cost asymmetry. To enable us to provide with a relative ranking however, we shall employ a counter intuitive example in which the variables assumed to differ will in the limit approximate each other: $\lim d_1 \rightarrow d_2$ and $\lim \varepsilon \rightarrow 0$. Then the profits under the cooperational regime can be written as:

$$\Pi^{NC} = \frac{(a - c_2)^2(2b + d_2)^3}{(5b^2 + 5bd_2 + d_2^2)^2}$$

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We examine the following two cases:

Case 1: $d_1 > d_2$

For this situation, we have already, through proposition 13, established that the ranking of the co-operational agreement profits takes the following form:

$$\Pi^J = \Pi^{Jc} > \Pi^c$$

²⁶ Note that the assumption $\lim d_1 \rightarrow d_2$ and $\lim c_1 \rightarrow c_2$ can also be written as $\lim d_2 \rightarrow d_1$ and $\lim c_2 \rightarrow c_1$, in which case the profits and welfare levels are given in the terms of the firm one cost parameter and will assist in the comparison when firm 1 is the monopolist in the market. These are given by:

$$\Pi^{NC} = \frac{(a - c_1)^2(2b + d_1)^3}{(5b^2 + 5bd_1 + d_1^2)^2}$$

$$W^{NC} = \frac{(a - c_1)^2(2b + d_1)(2b^2 + 4bd_1 + d_1^2)}{(5b^2 + 5bd_1 + d_1^2)^2}$$

Therefore for $\Pi^{NC} > \Pi^J$, and $\Pi^{NC} > \Pi^c$ the difference between these profit values must be positive.

$$\begin{aligned} & \Pi^{NC} - \Pi^J \\ &= \frac{(a - c_2)^2(2b + d_2)^3}{(5b^2 + 5bd_2 + d_2^2)^2} - \frac{(a - c_2)^2}{2(2b + d_2)} \end{aligned}$$

$$\begin{aligned} & \Pi^{NC} - \Pi^c \\ &= \frac{(a - c_2)^2(2b + d_2)^3}{(5b^2 + 5bd_2 + d_2^2)^2} - \frac{(a - c_2)^2}{8(2b + d_2)} \end{aligned}$$

The sign of this difference depends on the relative value of d_2

Thus, for low values of d_2

$$\lim_{d_2 \rightarrow 0} (\Pi^{NC} - \Pi^J) = \frac{7(a - c_2)^2}{100b} > 0 \Rightarrow \Pi^{NC} - \Pi^J > 0$$

\Rightarrow the ranking takes the form:

$$\Pi^{NC} > \Pi^J = \Pi^{Jc} > \Pi^c$$

And for high values of d_2

$$\lim_{d_2 \rightarrow -2b} (\Pi^{NC} - \Pi^J) = (a - c_2)^2(-\infty) < 0 \Rightarrow \Pi^{NC} - \Pi^J < 0$$

$$\lim_{d_2 \rightarrow -2b} (\Pi^{NC} - \Pi^c) = (a - c_2)^2(-\infty) < 0 \Rightarrow \Pi^{NC} - \Pi^c < 0$$

\Rightarrow the ranking takes the form:

$$\Pi^J = \Pi^{Jc} > \Pi^c > \Pi^{NC}$$

Therefore in summary: $\Pi^{NC} > \Pi^J = \Pi^{Jc} > \Pi^c$ for low d_2
 $\Pi^J = \Pi^{Jc} > \Pi^c > \Pi^{NC}$ otherwise

Case 2: $d_1 < d_2$

For $a > a^c > a^{Jc} > a^J$, we have established the following ranking for the cooperative profits :

$$\Pi^J = \Pi^{Jc} > \Pi^c$$

Therefore for $\Pi^{NC} > \Pi^J$, and $\Pi^{NC} > \Pi^c$ the difference between these profit values must be positive.

$$\begin{aligned} & \Pi^{NC} - \Pi^J \\ &= \frac{(a - c_1)^2(2b + d_1)^3}{(5b^2 + 5bd_1 + d_1^2)^2} - \frac{(a - c_1)^2}{2(2b + d_1)} \\ & \Pi^{NC} - \Pi^c \\ &= \frac{(a - c_1)^2(2b + d_1)^3}{(5b^2 + 5bd_1 + d_1^2)^2} - \frac{(a - c_1)^2}{8(2b + d_1)} \end{aligned}$$

The sign of this difference depends on the relative value of d_1

Thus, for low values of d_1

$$\lim_{d_1 \rightarrow 0} (\Pi^{NC} - \Pi^J) = \frac{7(a - c_1)^2}{100b} > 0 \Rightarrow \Pi^{NC} - \Pi^J > 0$$

\Rightarrow the ranking takes the form:

$$\Pi^{NC} > \Pi^J = \Pi^{Jc} > \Pi^c$$

And for high values of d_1

$$\begin{aligned} \lim_{d_1 \rightarrow -2b} (\Pi^{NC} - \Pi^J) &= (a - c_1)^2(-\infty) < 0 \Rightarrow \Pi^{NC} - \Pi^J < 0 \\ \lim_{d_1 \rightarrow -2b} (\Pi^{NC} - \Pi^c) &= (a - c_1)^2(-\infty) < 0 \Rightarrow \Pi^{NC} - \Pi^c < 0 \end{aligned}$$

\Rightarrow the ranking takes the form:

$$\Pi^J = \Pi^{Jc} > \Pi^c > \Pi^{NC}$$

For $a^c > a > a^{Jc} > a^J$, we have established the following ranking for the cooperative profits :

$$(1) \Pi^J > \Pi^{Jc} > \Pi^c$$

or

$$(2) \Pi^J > \Pi^c > \Pi^{Jc}$$

Therefore for (1), in order to be able to rank the co-operational and non co-operational outcomes, for $\Pi^{NC} > \Pi^J$, $\Pi^{NC} > \Pi^{Jc}$ and $\Pi^{NC} > \Pi^c$ the difference between these profit values must be positive.

$$\begin{aligned} & \Pi^{NC} - \Pi^J \\ &= \frac{(a - c_1)^2(2b + d_1)^3}{(5b^2 + 5bd_1 + d_1^2)^2} - \frac{(a - c_1)^2}{2(2b + d_1)} \end{aligned}$$

$$\begin{aligned} & \Pi^{NC} - \Pi^{Jc} \\ &= \frac{(a - c_2)^2(2b + d_2)^3}{(5b^2 + 5bd_2 + d_2^2)^2} - \frac{(a - c_2)^2}{2(2b + d_2)} \end{aligned}$$

$$\begin{aligned} & \Pi^{NC} - \Pi^c \\ &= \frac{(a - c_1)^2(2b + d_1)^3}{(5b^2 + 5bd_1 + d_1^2)^2} - \frac{(a - c_1)^2}{8(2b + d_1)} \end{aligned}$$

The sign of this difference depends on the relative value of d_1, d_2

Thus, for low values of d_1, d_2

$$\lim_{d_1 \rightarrow 0} (\Pi^{NC} - \Pi^J) = \frac{7(a - c_1)^2}{100b} > 0 \Rightarrow \Pi^{NC} - \Pi^J > 0$$

\Rightarrow the ranking takes the form:

$$\Pi^{NC} > \Pi^J = \Pi^{Jc} > \Pi^c$$

And for high values of d_1, d_2

$$\lim_{d_1 \rightarrow -2b} (\Pi^{NC} - \Pi^J) = (a - c_1)^2(-\infty) < 0 \Rightarrow \Pi^{NC} - \Pi^J < 0$$

$$\lim_{d_2 \rightarrow -2b} (\Pi^{NC} - \Pi^{Jc}) = (a - c_2)^2(-\infty) < 0 \Rightarrow \Pi^{NC} - \Pi^{Jc} < 0$$

$$\lim_{d_1 \rightarrow -2b} (\Pi^{NC} - \Pi^c) = (a - c_1)^2(-\infty) < 0 \Rightarrow \Pi^{NC} - \Pi^c < 0$$

\Rightarrow the ranking takes the form:

$$\Pi^J = \Pi^{Jc} > \Pi^c > \Pi^{NC}$$

For (2), in order to be able to rank the co-operational and non co-operational outcomes, for $\Pi^{NC} > \Pi^J$, $\Pi^{NC} > \Pi^{Jc}$ and $\Pi^{NC} > \Pi^c$ the difference between these profit values must be positive.

$$\begin{aligned} & \Pi^{NC} - \Pi^J \\ &= \frac{(a - c_1)^2(2b + d_1)^3}{(5b^2 + 5bd_1 + d_1^2)^2} - \frac{(a - c_1)^2}{2(2b + d_1)} \end{aligned}$$

$$\begin{aligned} & \Pi^{NC} - \Pi^c \\ &= \frac{(a - c_1)^2(2b + d_1)^3}{(5b^2 + 5bd_1 + d_1^2)^2} - \frac{(a - c_1)^2}{8(2b + d_1)} \end{aligned}$$

$$\begin{aligned} & \Pi^{NC} - \Pi^{Jc} \\ &= \frac{(a - c_2)^2(2b + d_2)^3}{(5b^2 + 5bd_2 + d_2^2)^2} - \frac{(a - c_2)^2}{2(2b + d_2)} \end{aligned}$$

The sign of this difference depends on the relative value of d_1, d_2

Thus, for low values of d_1, d_2

$$\lim_{d_1 \rightarrow 0} (\Pi^{NC} - \Pi^J) = \frac{7(a - c_1)^2}{100b} > 0 \Rightarrow \Pi^{NC} - \Pi^J > 0$$

\Rightarrow the ranking takes the form:

$$\Pi^{NC} > \Pi^J = \Pi^{Jc} > \Pi^c$$

And for high values of d_1, d_2

$$\lim_{d_1 \rightarrow -2b} (\Pi^{NC} - \Pi^J) = (a - c_1)^2(-\infty) < 0 \Rightarrow \Pi^{NC} - \Pi^J < 0$$

$$\lim_{d_1 \rightarrow -2b} (\Pi^{NC} - \Pi^c) = (a - c_1)^2(-\infty) < 0 \Rightarrow \Pi^{NC} - \Pi^c < 0$$

$$\lim_{d_2 \rightarrow -2b} (\Pi^{NC} - \Pi^{Jc}) = (a - c_2)^2(-\infty) < 0 \Rightarrow \Pi^{NC} - \Pi^{Jc} < 0$$

\Rightarrow the ranking takes the form:

$$\Pi^J = \Pi^{Jc} > \Pi^c > \Pi^{NC}$$

For $a^c > a^{Jc} > a > a^J$, we have established the following ranking for the cooperative profits :

$$\Pi^J > \Pi^{Jc} > \Pi^c$$

Therefore in order to be able to rank the co-operational and non co-operational outcomes, for $\Pi^{NC} > \Pi^J$, $\Pi^{NC} > \Pi^{Jc}$ and $\Pi^{NC} > \Pi^c$ the difference between these profit values must be positive.

$$\begin{aligned} & \Pi^{NC} - \Pi^J \\ &= \frac{(a - c_1)^2(2b + d_1)^3}{(5b^2 + 5bd_1 + d_1^2)^2} - \frac{(a - c_1)^2}{2(2b + d_1)} \end{aligned}$$

$$\begin{aligned} & \Pi^{NC} - \Pi^{Jc} \\ &= \frac{(a - c_2)^2(2b + d_2)^3}{(5b^2 + 5bd_2 + d_2^2)^2} - \frac{(a - c_2)^2}{2(2b + d_2)} \end{aligned}$$

$$\begin{aligned} & \Pi^{NC} - \Pi^c \\ &= \frac{(a - c_2)^2(2b + d_2)^3}{(5b^2 + 5bd_2 + d_2^2)^2} - \frac{(a - c_2)^2}{8(2b + d_2)} \end{aligned}$$

The sign of this difference depends on the relative value of d_1, d_2

Thus, for low values of d_1, d_2

$$\lim_{d_1 \rightarrow 0} (\Pi^{NC} - \Pi^J) = \frac{7(a - c_1)^2}{100b} > 0 \Rightarrow \Pi^{NC} - \Pi^J > 0$$

\Rightarrow the ranking takes the form:

$$\Pi^{NC} > \Pi^J = \Pi^{Jc} > \Pi^c$$

And for high values of d_1, d_2

$$\lim_{d_1 \rightarrow -2b} (\Pi^{NC} - \Pi^J) = (a - c_1)^2(-\infty) < 0 \Rightarrow \Pi^{NC} - \Pi^J < 0$$

$$\lim_{d_2 \rightarrow -2b} (\Pi^{NC} - \Pi^{Jc}) = (a - c_2)^2(-\infty) < 0 \Rightarrow \Pi^{NC} - \Pi^{Jc} < 0$$

$$\lim_{d_2 \rightarrow -2b} (\Pi^{NC} - \Pi^c) = (a - c_2)^2(-\infty) < 0 \Rightarrow \Pi^{NC} - \Pi^c < 0$$

\Rightarrow the ranking takes the form:

$$\Pi^J = \Pi^{Jc} > \Pi^c > \Pi^{NC}$$

Finally, for $a^c > a^{Jc} > a^J > a$, firm 2 becomes the monopolist, and as in case 1, we have established that the ranking of the co-operational agreement profits takes the following form:

$$\Pi^J = \Pi^{Jc} > \Pi^c$$

Therefore for $\Pi^{NC} > \Pi^J$, and $\Pi^{NC} > \Pi^c$ the difference between these profit values must be positive.

$$\begin{aligned} & \Pi^{NC} - \Pi^J \\ &= \frac{(a - c_2)^2(2b + d_2)^3}{(5b^2 + 5bd_2 + d_2^2)^2} - \frac{(a - c_2)^2}{2(2b + d_2)} \end{aligned}$$

$$\begin{aligned} & \Pi^{NC} - \Pi^c \\ &= \frac{(a - c_2)^2(2b + d_2)^3}{(5b^2 + 5bd_2 + d_2^2)^2} - \frac{(a - c_2)^2}{8(2b + d_2)} \end{aligned}$$

The sign of this difference depends on the relative value of d_2

Thus, for low values of d_2

$$\lim_{d_2 \rightarrow 0} (\Pi^{NC} - \Pi^J) = \frac{7(a - c_2)^2}{100b} > 0 \Rightarrow \Pi^{NC} - \Pi^J > 0$$

\Rightarrow the ranking takes the form:

$$\Pi^{NC} > \Pi^J = \Pi^{Jc} > \Pi^c$$

And for high values of d_2

$$\lim_{d_2 \rightarrow -2b} (\Pi^{NC} - \Pi^J) = (a - c_2)^2(-\infty) < 0 \Rightarrow \Pi^{NC} - \Pi^J < 0$$

$$\lim_{d_2 \rightarrow -2b} (\Pi^{NC} - \Pi^c) = (a - c_2)^2(-\infty) < 0 \Rightarrow \Pi^{NC} - \Pi^c < 0$$

\Rightarrow the ranking takes the form:

$$\Pi^J = \Pi^{Jc} > \Pi^c > \Pi^{NC}$$

Therefore in summary:

Market size	Regime	Monopolist	Ranking
$a > a^c > a^{Jc} > a^J$	J	Firm 1	$\Pi^{NC} > \Pi^J = \Pi^{Jc} > \Pi^c$ for low d_1 $\Pi^J = \Pi^{Jc} > \Pi^c > \Pi^{NC}$ otherwise
	c	Firm 1	
	Jc	Firm 1	
$a^c > a > a^{Jc} > a^J(1)$	J	Firm 1	$\Pi^{NC} > \Pi^J > \Pi^{Jc} > \Pi^c$ for low d_1 $\Pi^J > \Pi^{Jc} > \Pi^c > \Pi^{NC}$ otherwise
	c	Firm 1	
	Jc	Firm 2	
$a^c > a > a^{Jc} > a^J(2)$	J	Firm 1	$\Pi^{NC} > \Pi^J > \Pi^c > \Pi^{Jc}$ for low d_1 $\Pi^J > \Pi^c > \Pi^{Jc} > \Pi^{NC}$ otherwise
	c	Firm 1	
	Jc	Firm 2	
$a^c > a^{Jc} > a > a^J$	J	Firm 1	$\Pi^{NC} > \Pi^J > \Pi^{Jc} > \Pi^c$ for low d_2 $\Pi^J > \Pi^{Jc} > \Pi^c > \Pi^{NC}$ otherwise
	c	Firm 2	
	Jc	Firm 2	
$a^c > a^{Jc} > a^J > a$	J	Firm 2	$\Pi^{NC} > \Pi^J = \Pi^{Jc} > \Pi^c$ for low d_2 $\Pi^J = \Pi^{Jc} > \Pi^c > \Pi^{NC}$ otherwise
	c	Firm 2	
	Jc	Firm 2	

(Table 8: Profit Ranking under decreasing MC regime)

B.8 Proposition 15 Proof

The comparison of the cooperative and the non cooperative profit and welfare levels as described by equations 2.110-2.111 is complicated due to the existence of a large number of variables. We set $c_1 = c_2 + \varepsilon$, due to the cost asymmetry. To enable us to provide with a relative ranking however, we shall employ a counter intuitive example in which the variables assumed to differ will in the limit approximate each other: $\lim d_1 \rightarrow d_2$ and

$\lim \varepsilon \rightarrow 0$. Then the welfare level under the co-operational regime can be written as:

$$W^{NC} = \frac{(a - c_2)^2(2b + d_2)(2b^2 + 4bd_2 + d_2^2)}{(5b^2 + 5bd_2 + d_2^2)^2}$$

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We examine the following two cases:

Case 1: $d_1 > d_2$

For this situation, we have already, through proposition 14, established that the ranking of the co-operational agreement profits takes the following form:

$$W^J = W^{Jc} > W^c$$

Therefore for $W^{NC} > W^J$, and $W^{NC} > W^c$ the difference between these profit values must be positive.

$$\begin{aligned} & W^{NC} - W^J \\ = & \frac{(a - c_2)^2(2b + d_2)(2b^2 + 4bd_2 + d_2^2)}{(5b^2 + 5bd_2 + d_2^2)^2} - \frac{(a - c_2)^2}{2(2b + d_2)} \\ & W^{NC} - W^c \\ = & \frac{(a - c_2)^2(2b + d_2)(2b^2 + 4bd_2 + d_2^2)}{(5b^2 + 5bd_2 + d_2^2)^2} - \frac{3(a - c_2)^2}{8(2b + d_2)} \end{aligned}$$

The sign of this difference depends on the relative value of d_2

²⁷ Note that the assumption $\lim d_1- > d_2$ and $\lim c_1- > c_2$ can also be written as $\lim d_2- > d_1$ and $\lim c_2- > c_1$, in which case the profits and welfare levels are given in the terms of the firm one cost parameter and will assist in the comparison when firm 1 is the monopolist in the market. These are given by:

$$\begin{aligned} \Pi^{NC} &= \frac{(a - c_1)^2(2b + d_1)^3}{(5b^2 + 5bd_1 + d_1^2)^2} \\ W^{NC} &= \frac{(a - c_1)^2(2b + d_1)(2b^2 + 4bd_1 + d_1^2)}{(5b^2 + 5bd_1 + d_1^2)^2} \end{aligned}$$

Thus, for low values of d_2

$$\begin{aligned}\lim_{d_2 \rightarrow 0} (W^{NC} - W^J) &= \frac{-9(a - c_2)^2}{100b} < 0 \Rightarrow W^{NC} - W^J < 0 \\ \lim_{d_2 \rightarrow 0} (W^{NC} - W^c) &= \frac{-11(a - c_2)^2}{100b} < 0 \Rightarrow W^{NC} - W^c < 0\end{aligned}$$

\Rightarrow the ranking takes the form:

$$W^J = W^{Jc} > W^c > W^{NC}$$

And for high values of d_2

$$\begin{aligned}\lim_{d_2 \rightarrow -2b} (W^{NC} - W^J) &= (a - c_2)^2(-\infty) < 0 \Rightarrow W^{NC} - W^J < 0 \\ \lim_{d_2 \rightarrow -2b} (W^{NC} - W^c) &= (a - c_2)^2(-\infty) < 0 \Rightarrow W^{NC} - W^c < 0\end{aligned}$$

\Rightarrow the ranking takes the form:

$$W^J = W^{Jc} > W^c > W^{NC}$$

Therefore in summary:

$$W^J = W^{Jc} > W^c > W^{NC} \text{ for all values of } d_2$$

Case 2: $d_1 < d_2$

For $a > a^c > a^{Jc} > a^J$, we have established the following ranking for the cooperative profits :

$$W^J = W^{Jc} > W^c$$

Therefore for $W^{NC} > W^J$, and $W^{NC} > W^c$ the difference between these profit values must be positive.

$$\begin{aligned} & W^{NC} - W^J \\ = & \frac{(a - c_1)^2(2b + d_1)(2b^2 + 4bd_1 + d_1^2)}{(5b^2 + 5bd_1 + d_1^2)^2} - \frac{(a - c_1)^2}{2(2b + d_1)} \end{aligned}$$

$$\begin{aligned} & W^{NC} - W^c \\ = & \frac{(a - c_1)^2(2b + d_1)(2b^2 + 4bd_1 + d_1^2)}{(5b^2 + 5bd_1 + d_1^2)^2} - \frac{3(a - c_1)^2}{8(2b + d_1)} \end{aligned}$$

The sign of this difference depends on the relative value of d_1

Thus, for low values of d_1

$$\begin{aligned} \lim_{d_1 \rightarrow 0} (W^{NC} - W^J) &= \frac{-9(a - c_1)^2}{100b} < 0 \Rightarrow W^{NC} - W^J < 0 \\ \lim_{d_1 \rightarrow 0} (W^{NC} - W^c) &= \frac{-11(a - c_1)^2}{400b} < 0 \Rightarrow W^{NC} - W^c < 0 \end{aligned}$$

\Rightarrow the ranking takes the form:

$$W^J = W^{Jc} > W^c > W^{NC}$$

And for high values of d_1

$$\begin{aligned} \lim_{d_1 \rightarrow -2b} (W^{NC} - W^J) &= (a - c_1)^2(-\infty) < 0 \Rightarrow W^{NC} - W^J < 0 \\ \lim_{d_1 \rightarrow -2b} (W^{NC} - W^c) &= (a - c_1)^2(-\infty) < 0 \Rightarrow W^{NC} - W^c < 0 \end{aligned}$$

\Rightarrow the ranking takes the form:

$$W^J = W^{Jc} > W^c > W^{NC}$$

For $a^c > a > a^{Jc} > a^J$, we have established the following ranking for the cooperative profits :

$$(1) W^J > W^{Jc} > W^c$$

or

$$(2) W^J > W^c > W^{Jc}$$

Therefore for (1), in order to be able to rank the co-operational and non co-operational outcomes, for $W^{NC} > W^J$, $W^{NC} > W^{Jc}$ and $W^{NC} > W^c$ the difference between these profit values must be positive.

$$\begin{aligned} & W^{NC} - W^J \\ = & \frac{(a - c_1)^2(2b + d_1)(2b^2 + 4bd_1 + d_1^2)}{(5b^2 + 5bd_1 + d_1^2)^2} - \frac{(a - c_1)^2}{2(2b + d_1)} \end{aligned}$$

$$\begin{aligned} & W^{NC} - W^{Jc} \\ = & \frac{(a - c_2)^2(2b + d_2)(2b^2 + 4bd_2 + d_2^2)}{(5b^2 + 5bd_2 + d_2^2)^2} - \frac{(a - c_2)^2}{2(2b + d_2)} \end{aligned}$$

$$\begin{aligned} & W^{NC} - W^c \\ = & \frac{(a - c_1)^2(2b + d_1)(2b^2 + 4bd_1 + d_1^2)}{(5b^2 + 5bd_1 + d_1^2)^2} - \frac{3(a - c_1)^2}{8(2b + d_1)} \end{aligned}$$

The sign of this difference depends on the relative value of d_1, d_2

Thus, for low values of d_1, d_2

$$\lim_{d_1 \rightarrow 0} (W^{NC} - W^J) = \frac{-9(a - c_1)^2}{100b} < 0 \Rightarrow W^{NC} - W^J < 0$$

$$\lim_{d_2 \rightarrow 0} (W^{NC} - W^{Jc}) = \frac{-9(a - c_2)^2}{100b} < 0 \Rightarrow W^{NC} - W^{Jc} < 0$$

$$\lim_{d_1 \rightarrow 0} (W^{NC} - W^c) = \frac{-11(a - c_1)^2}{400b} < 0 \Rightarrow W^{NC} - W^c < 0$$

\Rightarrow the ranking takes the form:

$$W^J > W^{Jc} > W^c > W^{NC}$$

And for high values of d_1, d_2

$$\lim_{d_1 \rightarrow -2b} (W^{NC} - W^J) = (a - c_1)^2(-\infty) < 0 \Rightarrow W^{NC} - W^J < 0$$

$$\lim_{d_2 \rightarrow -2b} (W^{NC} - W^{Jc}) = (a - c_1)^2(-\infty) < 0 \Rightarrow W^{NC} - W^{Jc} < 0$$

$$\lim_{d_1 \rightarrow -2b} (W^{NC} - W^c) = (a - c_1)^2(-\infty) < 0 \Rightarrow W^{NC} - W^c < 0$$

\Rightarrow the ranking takes the form:

$$W^J > W^{Jc} > W^c > W^{NC}$$

For (2), in order to be able to rank the co-operational and non co-operational outcomes, for $W^{NC} > W^J$, $W^{NC} > W^{Jc}$ and $W^{NC} > W^c$ the difference between these profit values must be positive.

$$\begin{aligned} & W^{NC} - W^J \\ = & \frac{(a - c_1)^2(2b + d_1)(2b^2 + 4bd_1 + d_1^2)}{(5b^2 + 5bd_1 + d_1^2)^2} - \frac{(a - c_1)^2}{2(2b + d_1)} \end{aligned}$$

$$\begin{aligned} & W^{NC} - W^c \\ = & \frac{(a - c_1)^2(2b + d_1)(2b^2 + 4bd_1 + d_1^2)}{(5b^2 + 5bd_1 + d_1^2)^2} - \frac{3(a - c_1)^2}{8(2b + d_1)} \end{aligned}$$

$$\begin{aligned} & W^{NC} - W^{Jc} \\ = & \frac{(a - c_2)^2(2b + d_2)(2b^2 + 4bd_2 + d_2^2)}{(5b^2 + 5bd_2 + d_2^2)^2} - \frac{(a - c_2)^2}{2(2b + d_2)} \end{aligned}$$

The sign of this difference depends on the relative value of d_1, d_2

Thus, for low values of d_1, d_2

$$\begin{aligned}\lim_{d_1 \rightarrow 0} (W^{NC} - W^J) &= \frac{-9(a - c_1)^2}{100b} < 0 \Rightarrow W^{NC} - W^J < 0 \\ \lim_{d_1 \rightarrow 0} (W^{NC} - W^c) &= \frac{-11(a - c_1)^2}{400b} < 0 \Rightarrow W^{NC} - W^c < 0 \\ \lim_{d_2 \rightarrow 0} (W^{NC} - W^{Jc}) &= \frac{-9(a - c_2)^2}{100b} < 0 \Rightarrow W^{NC} - W^{Jc} < 0\end{aligned}$$

\Rightarrow the ranking takes the form:

$$W^J > W^c > W^{Jc} > W^{NC}$$

And for high values of d_1, d_2

$$\begin{aligned}\lim_{d_1 \rightarrow -2b} (W^{NC} - W^J) &= (a - c_1)^2(-\infty) < 0 \Rightarrow W^{NC} - W^J < 0 \\ \lim_{d_1 \rightarrow -2b} (W^{NC} - W^c) &= (a - c_1)^2(-\infty) < 0 \Rightarrow W^{NC} - W^c < 0 \\ \lim_{d_2 \rightarrow -2b} (W^{NC} - W^{Jc}) &= (a - c_1)^2(-\infty) < 0 \Rightarrow W^{NC} - W^{Jc} < 0\end{aligned}$$

\Rightarrow the ranking takes the form:

$$W^J > W^c > W^{Jc} > W^{NC}$$

For $a^c > a^{Jc} > a > a^J$, we have established the following ranking for the cooperative profits :

$$W^J > W^{Jc} > W^c$$

Therefore in order to be able to rank the co-operational and non co-operational outcomes, for $W^{NC} > W^J$, $W^{NC} > W^{Jc}$ and $W^{NC} > W^c$ the difference between these profit

values must be positive.

$$\begin{aligned} & W^{NC} - W^J \\ &= \frac{(a - c_1)^2(2b + d_1)(2b^2 + 4bd_1 + d_1^2)}{(5b^2 + 5bd_1 + d_1^2)^2} - \frac{(a - c_1)^2}{2(2b + d_1)} \end{aligned}$$

$$\begin{aligned} & W^{NC} - W^{Jc} \\ &= \frac{(a - c_2)^2(2b + d_2)(2b^2 + 4bd_2 + d_2^2)}{(5b^2 + 5bd_2 + d_2^2)^2} - \frac{(a - c_2)^2}{2(2b + d_2)} \end{aligned}$$

$$\begin{aligned} & W^{NC} - W^c \\ &= \frac{(a - c_2)^2(2b + d_2)(2b^2 + 4bd_2 + d_2^2)}{(5b^2 + 5bd_2 + d_2^2)^2} - \frac{3(a - c_2)^2}{8(2b + d_2)} \end{aligned}$$

The sign of this difference depends on the relative value of d_1, d_2

Thus, for low values of d_1, d_2

$$\begin{aligned} \lim_{d_1 \rightarrow 0} (W^{NC} - W^J) &= \frac{-9(a - c_1)^2}{100b} < 0 \Rightarrow W^{NC} - W^J < 0 \\ \lim_{d_2 \rightarrow 0} (W^{NC} - W^{Jc}) &= \frac{-9(a - c_2)^2}{100b} < 0 \Rightarrow W^{NC} - W^{Jc} < 0 \\ \lim_{d_2 \rightarrow 0} (W^{NC} - W^c) &= \frac{-11(a - c_2)^2}{400b} < 0 \Rightarrow W^{NC} - W^c < 0 \end{aligned}$$

\Rightarrow the ranking takes the form:

$$W^J > W^{Jc} > W^c > W^{NC}$$

And for high values of d_1, d_2

$$\begin{aligned} \lim_{d_1 \rightarrow -2b} (W^{NC} - W^J) &= (a - c_1)^2(-\infty) < 0 \Rightarrow W^{NC} - W^J < 0 \\ \lim_{d_2 \rightarrow -2b} (W^{NC} - W^{Jc}) &= (a - c_1)^2(-\infty) < 0 \Rightarrow W^{NC} - W^{Jc} < 0 \\ \lim_{d_1 \rightarrow -2b} (W^{NC} - W^c) &= (a - c_1)^2(-\infty) < 0 \Rightarrow W^{NC} - W^c < 0 \end{aligned}$$

\Rightarrow the ranking takes the form:

$$W^J > W^{Jc} > W^c > W^{NC}$$

Finally, for $a^c > a^{Jc} > a^J > a$, firm 2 becomes the monopolist, and as in case 1, we have established that the ranking of the co-operational agreement welfare takes the following form:

$$W^J = W^{Jc} > W^c$$

Therefore for $W^{NC} > W^J$, and $W^{NC} > W^c$ the difference between these profit values must be positive.

$$\begin{aligned} & W^{NC} - W^J \\ = & \frac{(a - c_2)^2(2b + d_2)(2b^2 + 4bd_2 + d_2^2)}{(5b^2 + 5bd_2 + d_2^2)^2} - \frac{(a - c_2)^2}{2(2b + d_2)} \end{aligned}$$

$$\begin{aligned} & W^{NC} - W^c \\ = & \frac{(a - c_2)^2(2b + d_2)(2b^2 + 4bd_2 + d_2^2)}{(5b^2 + 5bd_2 + d_2^2)^2} - \frac{3(a - c_2)^2}{8(2b + d_2)} \end{aligned}$$

The sign of this difference depends on the relative value of d_2

Thus, for low values of d_2

$$\begin{aligned} \lim_{d_2 \rightarrow 0} (W^{NC} - W^J) &= \frac{-9(a - c_2)^2}{100b} < 0 \Rightarrow W^{NC} - W^J < 0 \\ \lim_{d_2 \rightarrow 0} (W^{NC} - W^c) &= \frac{-11(a - c_2)^2}{100b} < 0 \Rightarrow W^{NC} - W^c < 0 \end{aligned}$$

\Rightarrow the ranking takes the form:

$$W^J = W^{Jc} > W^c > W^{NC}$$

And for high values of d_2

$$\lim_{d_2 \rightarrow -2b} (W^{NC} - W^J) = (a - c_2)^2(-\infty) < 0 \Rightarrow W^{NC} - W^J < 0$$

$$\lim_{d_2 \rightarrow -2b} (W^{NC} - W^c) = (a - c_2)^2(-\infty) < 0 \Rightarrow W^{NC} - W^c < 0$$

\Rightarrow the ranking takes the form:

$$W^J = W^{Jc} > W^c > W^{NC}$$

Therefore in summary:

$$W^J = W^{Jc} > W^c > W^{NC} \text{ for all values of } d_2$$

In summary:

Market size	Regime	Monopolist	Ranking
$a > a^c > a^{Jc} > a^J$	J	Firm 1	$W^J = W^{Jc} > W^c > W^{NC}$
	c	Firm 1	
	Jc	Firm 1	
$a^c > a > a^{Jc} > a^J$	J	Firm 1	$W^J > W^c > W^{Jc} > W^{NC}$ or $W^J > W^{Jc} > W^c > W^{NC}$ depending on the rates d_1 and d_2
	c	Firm 1	
	Jc	Firm 2	
$a^c > a^{Jc} > a > a^J$	J	Firm 1	$W^J > W^{Jc} > W^c > W^{NC}$
	c	Firm 2	
	Jc	Firm 2	
$a^c > a^{Jc} > a^J > a$	J	Firm 2	$W^J = W^{Jc} > W^c > W^{NC}$
	c	Firm 2	
	Jc	Firm 2	

(Table 9: Welfare Ranking under decreasing MC regime)

Appendix C

Appendix for Chapter 3

C.1 Acquisition Price

The foreign firm will make a take it or leave it offer to the selected domestic firm over the acquisition price, which must at least be equal to the outside option profits, in order to be accepted by the domestic firm. The foreign firm faces zero profits should it choose not to enter, implying that it will always choose to enter the market. This is perceived by the domestic firm approached, as a credible threat of a definite entry. Therefore, the firm, will face entry by the foreign firm either through greenfield investment or exports, if it chooses to reject the acquisition. The outside option, for the domestic firm, will therefore be profits under greenfield investment or exports, depending on the level of greenfield investment, which in turn defines the optimal choice of the foreign firm.

Here we examine the symmetric case, however for the asymmetric case the approach would be similar. The foreign profits are given by:

$$\Pi_F^{Se} = \frac{(a + \theta - (n + 1)t + nc)^2}{(n + 2)^2}$$

and

$$\Pi_F^{Sg} = \frac{(a + \theta + nc)^2}{(n + 2)^2} - G$$

for the options of exporting and greenfield investment respectively.

The above two functions, and in particular the value of term G , define the probable alternative entry mode, if acquisition is rejected, and in extension the outside option profits for the domestic firm. Therefore, if $G < G'' \Leftrightarrow \Pi_F^{Sg} > \Pi_F^{Se}$, the entry mode is greenfield investment and the profits that the domestic firm would realize equals: $\Pi_{Hi}^{Sg} = \frac{(a+\theta-2c)^2}{(n+2)^2}$. Alternatively, if $G > G'' \Leftrightarrow \Pi_F^{Sg} < \Pi_F^{Se}$, the entry mode is exporting and the profits that the domestic firm would realize equals: $\Pi_{Hi}^{Se} = \frac{(a+\theta-2c+t)^2}{(n+2)^2}$.

The acquisition price is given by the weighted sum of the profits: $V = \beta \Pi_{Hi}^{Sg} + (1-\beta) \Pi_{Hi}^{Se}$; when greenfield investment is the outside option, $\beta = 1$, thus $V = \Pi_{Hi}^{Sg}$, whereas when exporting is the outside option, $\beta = 0$, thus $V = \Pi_{Hi}^{Se}$.

C.2 Proposition 16 Proof

(1) For greenfield investment to be the preferred option compared to acquisition then the expected profit from greenfield must exceed the expected profit from acquisition. Therefore:

$$E(\Pi_F^{Sg} - \Pi_F^{Sacq}) > 0 \Leftrightarrow$$

$$G < \frac{(a+nc)^2}{(n+2)^2} - \frac{(a+(n-1)c)^2}{(n+1)^2} + \beta \frac{(a-2c)^2}{(n+2)^2}$$

$$+ (1-\beta) \frac{(a-2c+t)^2}{(n+2)^2} + \frac{(n^2-2)\sigma^2}{(n+1)^2(n+2)^2}$$

Setting the right hand side of the inequality equal to G' , the above expression becomes

$$E(\Pi_F^{Sg} - \Pi_F^{Sacq}) > 0 \Leftrightarrow G < G'$$

(2) For greenfield investment to be the preferred option compared to exports the expected profit from greenfield must exceed the expected profit from exports. Therefore:

$$E(\Pi_F^{Sg} - \Pi_F^{Se}) > 0 \Leftrightarrow$$

$$G < \frac{(a + nc)^2 - (a + nc - (n + 1)t)^2}{(n + 2)^2}$$

Setting the right hand side of the inequality equal to G'' , the expression becomes

$$E(\Pi_F^{Sg} - \Pi_F^{Se}) > 0 \Leftrightarrow G < G''$$

C.3 Proposition 17 Proof

(1) For greenfield investment to be the preferred option compared to exports the expected welfare from greenfield must exceed the expected welfare from exports. Therefore:

$$E(W^{Sg} - W^{Se}) > 0 \Leftrightarrow$$

$$G > \frac{2n(a - 2c + t)^2 + [(n + 1)a - nc - t]^2 - 2n(a - 2c)^2}{2(n + 2)^2}$$

$$+ \frac{(n + 2)t(a - (n + 1)t + nc) - [(n + 1)a - nc]^2}{2(n + 2)^2}$$

Setting the right hand side of the inequality equal to G^* , the above expression becomes

$$E(W^{Sg} - W^{Se}) > 0 \Leftrightarrow G > G^*$$

(2) Similarly, for greenfield investment to be the government's preferred entry mode option compared to an acquisition then the expected welfare level from greenfield must

exceed the expected welfare from acquisition. Therefore:

$$\begin{aligned}
 E(W^{Sg} - W^{Sacq}) &> 0 \Leftrightarrow \\
 G &> \frac{2(n-1)(a-2c)^2 + (na - (n-1)c)^2}{2(n+1)^2} \\
 &\quad - \frac{2n(a-2c)^2 + ((n+1)a - nc)^2}{2(n+2)^2} \\
 &\quad + \frac{\beta(a-2c)^2 + (1-\beta)(a-2c+t)^2}{(n+2)^2} \\
 &\quad + \frac{[2(n-1) + n^2]\sigma^2}{2(n+1)^2} \\
 &\quad - \frac{[2(n-1) + (n+1)^2]\sigma^2}{2(n+2)^2}
 \end{aligned}$$

Setting the right hand side of the inequality equal to G^{**} , the above expressions becomes:

$$E(W^{Sg} - W^{Sacq}) > 0 \Leftrightarrow G > G^{**}$$

(3) The government will prefer the foreign firm not to enter the market when its entry option is greenfield investment, if the cost is below G^{***} , where

$$G^{***} = \frac{n(n+2)(a-c)^2}{2(n+1)^2} - \frac{2n(a-2c)^2 + [(n+1)a - nc]^2}{2(n+2)^2} + \frac{(n+2)n\sigma^2}{2(n+1)^2} - \frac{[2n + (n+1)^2]\sigma^2}{2(n+2)^2}$$

C.4 Proposition 18 Proof

(1) For greenfield investment to be the preferred option compared to acquisition then the expected profit from greenfield must exceed the expected profit from acquisition. There-

fore:

$$E(\Pi_F^{A(u)g} - \Pi_F^{A(in)acq}) > 0 \Leftrightarrow$$

$$G < \frac{(a+nc)^2}{(n+2)^2} - \frac{(a+(n-1)c)^2}{(n+1)^2} + \beta \frac{(a-2c)^2}{(n+2)^2} \\ + (1-\beta) \frac{(a-2c+t)^2}{(n+2)^2} + \frac{(n^2-2)\sigma^2}{(n+1)^2(n+2)^2} - \frac{(n^2-2)\sigma^2}{(n+1)^2(n+2)^2}$$

Setting $\frac{(a+nc)^2}{(n+2)^2} - \frac{(a+(n-1)c)^2}{(n+1)^2} + \beta \frac{(a-2c)^2}{(n+2)^2} + (1-\beta) \frac{(a-2c+t)^2}{(n+2)^2} + \frac{(n^2-2)\sigma^2}{(n+1)^2(n+2)^2} = G'$ and $(-\frac{(n^2-2)\sigma^2}{(n+1)^2(n+2)^2}) = [c]$, the above expression becomes

$$E(\Pi_F^{A(u)g} - \Pi_F^{A(in)acq}) > 0 \Leftrightarrow G < G' + [c]$$

Note that the term $[c]$ captures the difference between the critical value under the symmetric versus asymmetric case of comparison between greenfield investment and acquisition.

(2) For greenfield investment to be the preferred option compared to exports the expected profit from greenfield must exceed the expected profit from exports. Therefore:

$$E(\Pi_F^{A(u)g} - \Pi_F^{A(u)e}) > 0 \Leftrightarrow$$

$$G < \frac{(a+nc)^2 - (a+nc - (n+1)t)^2}{(n+2)^2}$$

Setting $\frac{(a+nc)^2 - (a+nc - (n+1)t)^2}{(n+2)^2} = G''$, the expression becomes

$$E(\Pi_F^{A(u)g} - \Pi_F^{A(u)e}) > 0 \Leftrightarrow G < G''$$

C.5 Proposition 19 Proof

(1) For greenfield investment to be the preferred option compared to acquisition then the expected profit from greenfield must exceed the expected profit from acquisition. There-

fore:

$$E(W^{Ag} - W^{Acq}) > 0 \Leftrightarrow$$

$$G > \frac{2(n-1)(a-2c)^2 + (na - (n-1)c)^2}{2(n+1)^2} - \frac{2n(a-2c)^2 + ((n+1)a - nc)^2}{2(n+2)^2} + \frac{\beta(a-2c)^2 + (1-\beta)(a-2c+t)^2}{(n+2)^2}$$

$$\text{Setting } \frac{2(n-1)(a-2c)^2 + (na - (n-1)c)^2}{2(n+1)^2} - \frac{2n(a-2c)^2 + ((n+1)a - nc)^2}{2(n+2)^2} + \frac{\beta(a-2c)^2 + (1-\beta)(a-2c+t)^2}{(n+2)^2} + \frac{[2(n-1)+n^2]\sigma^2}{2(n+1)^2} -$$

$$\frac{[2(n-1)+(n+1)^2]\sigma^2}{2(n+2)^2} = G^{**}, \left(-\frac{[2(n-1)+n^2]\sigma^2}{2(n+1)^2} + \frac{[2(n-1)+(n+1)^2]\sigma^2}{2(n+2)^2} \right) = [a] \text{ and the above expression}$$

becomes

$$E(W^{Ag} - W^{Acq}) > 0 \Leftrightarrow G > G^{**} + [a]$$

(2) For greenfield investment to be the preferred option compared to exports the expected profit from greenfield must exceed the expected profit from exports. Therefore:

$$E(W^{Ag} - W^{Ae}) > 0 \Leftrightarrow$$

$$G > \frac{2n(a-2c+t)^2 + [(n+1)a - nc - t]^2 - 2n(a-2c)^2}{2(n+2)^2} + \frac{(n+2)t(a - (n+1)t + nc) - [(n+1)a - nc]^2}{2(n+2)^2}$$

$$\text{Setting } \frac{2n(a-2c+t)^2 + [(n+1)a - nc - t]^2 - 2n(a-2c)^2}{2(n+2)^2} + \frac{(n+2)t(a - (n+1)t + nc) - [(n+1)a - nc]^2}{2(n+2)^2} = G^*, \text{ the ex-}$$

pression becomes

$$E(W^{Ag} - W^{Ae}) > 0 \Leftrightarrow G > G^*$$

(3) Lastly, the government will prefer the foreign firm not to enter the market when its entry option is greenfield investment, if the cost is below $G^{***} + [b]$, where

$$G^{***} = \frac{n(n+2)(a-c)^2}{2(n+1)^2} - \frac{2n(a-2c)^2 + [(n+1)a - nc]^2}{2(n+2)^2} + \frac{(n+2)n\sigma^2}{2(n+1)^2} - \frac{[2n + (n+1)^2]\sigma^2}{2(n+2)^2}$$

and

$$[b] = (-\frac{(n + 2)n\sigma^2}{2(n + 1)^2} + \frac{[2n + (n + 1)^2]\sigma^2}{2(n + 2)^2})$$

C.6 Appendix 6

When the optimal choice of the firm is greenfield investment, there are three options that the government may prefer. The following tables summarize the policy measures provided and the optimal measures that the firm would be willing to accept for a mode switch. The first column provides the two modes being compared (*e, g, acq*), for example **Exports versus Greenfield FDI** which appears as (*e vs g*), with Table 1 providing comparisons when the preferred mode of the firm is Greenfield Investment (*g*), Table 2 the comparisons when Acquisition (*acq*) is the firm preferred choice and lastly, Table 3 examines exports (*e*) as the firm’s preferred mode. The second column denotes the information framework we are in at each point and columns 3 and 4 provide the optimal measures preferred by the policymaker and the foreign firm respectively. The final column provides the mode switch

ion for this mode change to be realized.

Entry Mode Comparison	Information	Government	Foreign firm	Mode switch condition
<i>e</i> <i>vs</i> <i>g</i>	<i>S</i>	$S_p^{Se(g)} = G^* - G$	$S_F^{Se(g)} = G'' - G$	$G^* > G''$
<i>e</i> <i>vs</i> <i>g</i>	<i>A</i>	$S_p^{Ae(g)} = G^* - G$	$S_F^{Se(g)} = G'' - G$	$G^* > G''$
<i>acq</i> <i>vs</i> <i>g</i>	<i>S</i>	$S_p^{Sacq(g)} = G^{**} - G$	$S_F^{Sacq(g)} = G' - G$	$G^{**} > G'$
<i>acq</i> <i>vs</i> <i>g</i>	<i>A</i>	$S_p^{Acq(g)} = G^{**} - G$ $- \frac{[2(n-1)+n^2]\sigma^2}{2(n+1)^2}$ $+ \frac{[2(n-1)+(n+1)^2]\sigma^2}{2(n+2)^2}$	$S_F^{Acq(g)} = G' - G$ $- \frac{(n^2-2)\sigma^2}{(n+2)^2(n+1)^2}$	$G^{**} + [a] > G' + [c]$
<i>ne</i> <i>vs</i> <i>g</i>	<i>S</i>	$S_p^{Sne(g)} = G^{***} - G$	$S_F^{Sne(g)} = \frac{(a+nc)^2}{(n+2)^2}$ $+ \frac{\sigma^2}{(n+2)^2} - G$	$G^{***} >$ $\frac{(a+nc)^2}{(n+2)^2} + \frac{\sigma^2}{(n+2)^2}$
<i>ne</i> <i>vs</i> <i>g</i>	<i>A</i>	$S_p^{Ane(g)} = G^{***} - G$ $- \frac{(n+2)n\sigma^2}{2(n+1)^2} + \frac{[2n+(n+1)^2]\sigma^2}{2(n+2)^2}$	$S_F^{Ane(g)} = \frac{(a+nc)^2}{(n+2)^2} - G$	$G^{***} >$ $\frac{(a+nc)^2}{(n+2)^2} + \frac{(n+2)n\sigma^2}{2(n+1)^2}$ $- \frac{[2n+(n+1)^2]\sigma^2}{2(n+2)^2}$

(Table 1: Mode Switch Conditions when Firm Choice is Greenfield Investment)

Entry Mode	Info	Government	Foreign Firm	Mode switch condition
e vs acq	S	$S_p^{Se(acq)} = \frac{2n(a-2c+t)^2 + [(n+1)a-t-nc]^2}{2(n+2)^2} - \frac{2(n-1)(a-2c)^2}{2(n+1)^2} - \frac{[na-(n-1)c]^2}{2(n+1)^2} - \frac{\beta(a-2c)^2 + (1-\beta)(a-2c+t)^2}{(n+2)^2} + \frac{(n+2)t(a-(n+1)t+nc)}{2(n+2)^2}$	$S_F^{Se(acq)} = \frac{[a+(n-1)c]^2}{(n+1)^2} - \frac{\beta(a-2c)^2}{(n+2)^2} - \frac{(1-\beta)(a-2c+t)^2}{(n+2)^2} - \frac{[a+nc-(n+1)t]^2}{(n+2)^2} - \frac{2\sigma^2}{(n+2)^2} + \frac{\sigma^2}{(n+1)^2}$	$S_p^{Se(acq)} > S_F^{Se(acq)}$
e vs acq	A	$S_p^{Ae(acq)} = \frac{2n(a-2c+t)^2 + [(n+1)a-t-nc]^2}{2(n+2)^2} - \frac{2(n-1)(a-2c)^2}{2(n+1)^2} - \frac{[na-(n-1)c]^2}{2(n+1)^2} - \frac{\beta(a-2c)^2 + (1-\beta)(a-2c+t)^2}{(n+2)^2} + \frac{(n+2)t(a-(n+1)t+nc)}{2(n+2)^2}$	$S_F^{Ae(acq)} = \frac{[a+(n-1)c]^2}{(n+1)^2} - \frac{\beta(a-2c)^2}{(n+2)^2} - \frac{(1-\beta)(a-2c+t)^2}{(n+2)^2} - \frac{[a+nc-(n+1)t]^2}{(n+2)^2}$	$S_p^{Ae(acq)} > S_F^{Ae(acq)}$
g vs acq	S	$S_p^{Sg(acq)} = G - G^{**}$	$S_F^{Sg(acq)} = G - G'$	$G^{**} < G'$
g vs acq	A	$S_p^{Ag(acq)} = G - G^{**} + \frac{[2(n-1)+n^2]\sigma^2}{2(n+1)^2} - \frac{[2(n-1)+(n+1)^2]\sigma^2}{2(n+2)^2}$	$S_F^{AG(acq)} = G - G' + \frac{(n^2-2)\sigma^2}{(n+2)^2(n+1)^2}$	$G^{**} + [a] < G' + [c]$
ne vs acq	S	$S_p^{Sne(acq)} = \frac{n(n+2)(a-c)^2}{2(n+1)^2} - \frac{[2(n-1)(a-2c)^2 + (na-(n-1)c)^2]}{2(n+1)^2} + \frac{2\sigma^2}{2(n+1)^2}$	$S_F^{sne(acq)} = \frac{[a+(n-1)c]^2}{(n+1)^2} - \frac{\beta(a-2c)^2 + (1-\beta)(a-2c+t)^2}{(n+2)^2} + \frac{\sigma^2}{(n+1)^2} - \frac{\sigma^2}{(n+2)^2}$	$S_p^{Sne(acq)} > S_F^{Sne(acq)}$
ne vs acq	A	$S_p^{Ane(acq)} = \frac{n(n+2)(a-c)^2}{2(n+1)^2} - \frac{[2(n-1)(a-2c)^2 + (na-(n-1)c)^2]}{2(n+1)^2} - \frac{\beta(a-2c)^2 + (1-\beta)(a-2c+t)^2}{(n+2)^2}$	$S_F^{Ane(acq)} = \frac{[a+(n-1)c]^2}{(n+1)^2} - \frac{\beta(a-2c)^2 + (1-\beta)(a-2c+t)^2}{(n+2)^2}$	$S_p^{Ane(acq)} > S_F^{Ane(acq)}$

(Table 2: Mode Switch Conditions when Firm Choice is Acquisition)

Entry Mode	Info	Government	Foreign Firm	Mode switch condition
g vs e	S	$S_p^{Sg(e)} = G - G^*$	$S_F^{Sg(e)} = G - G''$	$G^* < G''$
g vs e	A	$S_p^{Ag(e)} = G - G^*$	$S_F^{Sg(e)} = G - G''$	$G^* < G''$
ne vs e	S	$S_p^{Sne(e)} = \frac{n(n+2)(a-c)^2}{2(n+1)^2}$ $- \frac{[2n(a-2c+t)^2]}{2(n+2)^2}$ $- \frac{[(n+1)a-nc-t]^2}{2(n+2)^2}$ $- \frac{(n+2)t(a+nc-(n+1)t)}{2(n+2)^2}$ $- \frac{[2n+(n+1)^2]\sigma^2}{2(n+2)^2}$	$S_F^{Sne(e)}$ $= \frac{[a+nc-(n+1)t]^2}{(n+2)^2}$ $+ \frac{\sigma^2}{(n+2)^2}$	$S_p^{Sne(E)} > S_F^{Sne(e)}$
ne vs e	A	$S_p^{Ane(e)} = \frac{n(n+2)(a-c)^2}{2(n+1)^2}$ $- \frac{[2n(a-2c+t)^2]}{2(n+2)^2}$ $- \frac{[(n+1)a-nc-t]^2}{2(n+2)^2}$	$S_F^{Sne(e)} =$ $\frac{[a+nc-(n+1)t]^2}{(n+2)^2}$	$S_p^{Ane(E)} > S_F^{Ane(e)}$
acq vs e	S	$S_p^{Sacq(e)} =$ $\frac{(3n-2)\sigma^2}{2(n+1)^2} + \frac{(1-3n)\sigma^2}{2(n+2)^2}$ $+ \frac{\beta(a-2c)^2 + (1-\beta)(a-2c+t)^2}{(n+2)^2}$ $- \frac{2n(a-2c+t)^2}{2(n+2)^2}$ $- \frac{((n+1)a-nc-t)^2}{2(n+2)^2}$ $- \frac{(n+2)t(a+nc-(n+1)t)}{2(n+2)^2}$ $+ \frac{[2(n-1)(a-2c)^2]}{2(n+1)^2}$ $+ \frac{[(na-(n+1)c)^2]}{2(n+1)^2}$	$S_F^{Sacq(e)} = \frac{[a+(n-1)c]^2}{(n+1)^2}$ $- \frac{\beta(a-2c)^2}{(n+2)^2}$ $- \frac{(1-\beta)(a-2c+t)^2}{(n+2)^2}$ $- \frac{(a+nc-(n+1)t)^2}{(n+2)^2}$ $+ \frac{\sigma^2}{(n+1)^2} - \frac{\sigma^2}{(n+2)^2}$	$S_p^{Sacq(e)} > S_F^{Sacq(e)}$
acq vs e	A	$S_p^{Aacq(e)} =$ $\frac{[2(n-1)(a-2c)^2 + (na-(n+1)c)^2]}{2(n+1)^2}$ $+ \frac{\beta(a-2c)^2 + (1-\beta)(a-2c+t)^2}{(n+2)^2}$ $- \frac{2n(a-2c+t)^2 + ((n+1)a-nc-t)^2}{2(n+2)^2}$	$S_F^{Aacq(e)} = \frac{[a+(n-1)c]^2}{(n+1)^2}$ $- \frac{\beta(a-2c)^2}{(n+2)^2}$ $- \frac{(1-\beta)(a-2c+t)^2}{(n+2)^2}$ $- \frac{(a+nc-(n+1)t)^2}{(n+2)^2}$	$S_p^{Aacq(e)} > S_F^{Aacq(e)}$

(Table 3: Mode Switch Conditions when Firm Choice is Exports)

C.7 Appendix 7

In the small market setting ($a = 10$), when $\beta = 0$, for the set values of variables a, c, t, n, σ , the following numerical results are derived, assisting in the ranking of the threshold values.

a	t	c	n	β	σ	G^*	$G^{\#}$	$G+[c]$	G	G^*	$G^*+[a]$	G^{**}	$G^{**}+[b]$
Small Market													
Cost													
10	1	1	2	0	2	1.53	3.94	0.62	0.67	-0.44	-0.27	3.65	3.50
10	1	2	2	0	2	1.41	4.69	-0.69	-0.63	-0.73	-0.56	2.97	2.82
10	1	3	2	0	2	1.28	5.44	-1.22	-1.16	-0.77	-0.60	1.93	1.78
10	1	4	2	0	2	1.16	6.19	-0.97	-0.91	-0.56	-0.40	0.53	0.38
10	1	5	2	0	2	1.03	6.94	0.06	0.12	-0.10	0.06	-1.24	-1.39
Tariff													
10	1	1	2	0	2	1.53	3.94	0.62	0.67	-0.44	-0.27	3.65	3.50
10	2	1	2	0	2	2.63	6.75	1.81	1.86	0.75	0.92	3.65	3.50
10	3	1	2	0	2	3.28	8.44	3.12	3.17	2.06	2.23	3.65	3.50
10	4	1	2	0	2	3.50	9.00	4.56	4.61	3.50	3.67	3.65	3.50
Number of domestic firms													
10	1	1	3	0	2	1.48	3.52	1.00	1.07	0.63	0.68	3.02	2.91
10	1	1	4	0	2	1.38	3.19	0.93	1.00	0.79	0.81	2.47	2.38
10	1	1	5	0	2	1.27	2.94	0.80	0.85	0.75	0.76	2.04	1.98
10	1	1	6	0	2	1.16	2.73	0.67	0.72	0.67	0.66	1.73	1.67
10	1	1	7	0	2	1.07	2.57	0.57	0.60	0.58	0.57	1.48	1.44
10	1	1	8	0	2	1.00	2.43	0.48	0.51	0.50	0.50	1.30	1.26
10	1	1	9	0	2	0.93	2.31	0.41	0.44	0.44	0.43	1.15	1.12
10	1	1	10	0	2	0.86	2.22	0.36	0.38	0.38	0.38	1.02	1.00
θ Parameter variation													
10	1	1	3	0	0	1.48	3.52	1.00	1.00	0.68	0.68	2.91	2.91
10	1	1	3	0	2	1.48	3.52	1.00	1.07	0.63	0.68	3.02	2.91
10	1	1	3	0	10	1.48	3.52	1.00	2.75	-0.69	0.68	5.78	2.91
10	1	1	3	0	100	1.48	3.52	1.00	176.00	-136.82	0.68	290.41	2.91

Table 15: Simulation Results for the Small Market

Similarly, when $\beta = 1$, the numerical values derived are given in the following table.

a	t	c	n	β	σ	G^*	G^*	$G+[c]$	G	G^*	$G^*+[a]$	G^{**}	$G^{**}+[b]$
Small Market													
Cost													
10	1	1	2	1	2	1.53	3.94	-0.44	-0.39	-1.50	-1.33	3.65	3.50
10	1	2	2	1	2	1.41	4.69	-1.50	-1.44	-1.54	-1.38	2.97	2.82
10	1	3	2	1	2	1.28	5.44	-1.78	-1.72	-1.33	-1.17	1.93	1.78
10	1	4	2	1	2	1.16	6.19	-1.28	-1.22	-0.88	-0.71	0.53	0.38
10	1	5	2	1	2	1.03	6.94	0.00	0.06	-0.17	0.00	-1.24	-1.39
Tariff													
10	1	1	2	1	2	1.53	3.94	-0.44	-0.39	-1.50	-1.33	3.65	3.50
10	2	1	2	1	2	2.63	6.75	-0.44	-0.39	-1.50	-1.33	3.65	3.50
10	3	1	2	1	2	3.28	8.44	-0.44	-0.39	-1.50	-1.33	3.65	3.50
10	4	1	2	1	2	3.50	9.00	-0.44	-0.39	-1.50	-1.33	3.65	3.50
Number of domestic firms													
10	1	1	3	1	2	1.48	3.52	0.32	0.39	-0.05	0.00	3.02	2.91
10	1	1	4	1	2	1.38	3.19	0.46	0.52	0.32	0.34	2.47	2.38
10	1	1	5	1	2	1.27	2.94	0.45	0.51	0.40	0.41	2.04	1.98
10	1	1	6	1	2	1.16	2.73	0.41	0.45	0.40	0.40	1.73	1.67
10	1	1	7	1	2	1.07	2.57	0.36	0.39	0.37	0.36	1.48	1.44
10	1	1	8	1	2	1.00	2.43	0.31	0.34	0.33	0.33	1.30	1.26
10	1	1	9	1	2	0.93	2.31	0.27	0.30	0.30	0.29	1.15	1.12
10	1	1	10	1	2	0.86	2.22	0.24	0.26	0.26	0.26	1.02	1.00
θ Parameter variation													
10	1	1	3	1	0	1.48	3.52	0.32	0.32	0.00	0.00	2.91	2.91
10	1	1	3	1	2	1.48	3.52	0.32	0.39	-0.05	0.00	3.02	2.91
10	1	1	3	1	10	1.48	3.52	0.32	2.07	-1.38	0.00	5.78	2.91
10	1	1	3	1	100	1.48	3.52	0.32	175.32	-137.50	0.00	290.41	2.91

Table 16: Simulation Results for the Small Market

When a large market is examined, which can be approximated by setting $a = 100$, the following tables are derived, firstly for $\beta = 0$ and then for $\beta = 1$.

For $\beta = 0$

a	t	c	n	β	σ	G^*	G^*	$G+[c]$	G	G^*	$G^*+[a]$	G^{**}	$G^{**}+[b]$
Large Market													
Cost													
100	10	10	10	0	2	86.46	221.53	35.68	35.70	37.52	37.52	99.89	99.86
100	10	20	10	0	2	107.29	374.31	11.09	11.12	17.81	17.81	111.08	111.05
100	10	30	10	0	2	128.13	527.08	-2.93	-2.91	5.11	5.10	96.44	96.42
100	10	40	10	0	2	148.96	679.86	-6.40	-6.38	-0.60	-0.60	55.98	55.96
100	10	50	10	0	2	169.79	832.64	0.69	0.72	0.70	0.69	-10.31	-10.33
Tariff													
100	10	10	10	0	2	86.46	221.53	35.68	35.70	37.52	37.52	99.89	99.86
100	11	10	10	0	2	90.86	234.44	36.94	36.96	38.78	38.77	99.89	99.86
100	12	10	10	0	2	94.50	245.67	38.21	38.23	40.05	40.04	99.89	99.86
100	13	10	10	0	2	97.36	255.22	39.49	39.52	41.34	41.33	99.89	99.86
100	14	10	10	0	2	99.46	263.08	40.79	40.81	42.63	42.63	99.89	99.86
Number of domestic firms													
100	10	10	10	0	2	86.46	221.53	35.68	35.70	37.52	37.52	99.89	99.86
100	10	10	11	0	2	81.07	213.02	31.10	31.12	32.94	32.94	90.24	90.22
100	10	10	12	0	2	76.28	205.61	27.32	27.34	29.11	29.11	82.18	82.16
100	10	10	13	0	2	72.00	199.11	24.17	24.19	25.88	25.88	75.35	75.34
100	10	10	14	0	2	68.16	193.36	21.53	21.54	23.15	23.14	69.51	69.50
100	10	10	15	0	2	64.71	188.24	19.29	19.30	20.81	20.80	64.47	64.46
θ Parameter variation													
100	10	10	10	0	0	86.46	221.53	35.68	35.68	37.52	37.52	99.86	99.86
100	10	10	10	0	2	86.46	221.53	35.68	35.70	37.52	37.52	99.89	99.86
100	10	10	10	0	10	86.46	221.53	35.68	36.24	37.67	37.52	100.49	99.86
100	10	10	10	0	100	86.46	221.53	35.68	91.92	52.44	37.52	162.71	99.86

Table 17: Simulation Results for the Large Market

and for $\beta = 1$

a	t	c	n	β	σ	G^*	G^*	$G^*+[c]$	G^*	G^*	$G^*+[a]$	G^*	$G^*+[b]$
Large Market													
Cost													
100	10	10	10	1	2	86.46	221.53	23.88	23.90	25.72	25.71	99.89	99.86
100	10	20	10	1	2	107.29	374.31	2.07	2.09	8.79	8.78	111.08	111.05
100	10	30	10	1	2	128.13	527.08	-9.18	-9.16	-1.14	-1.15	96.44	96.42
100	10	40	10	1	2	148.96	679.86	-9.87	-9.85	-4.07	-4.07	55.98	55.96
100	10	50	10	1	2	169.79	832.64	0.00	0.02	0.01	0.00	-10.31	-10.33
Tariff													
100	10	10	10	1	2	86.46	221.53	23.88	23.90	25.72	25.71	99.89	99.86
100	11	10	10	1	2	90.86	234.44	23.88	23.90	25.72	25.71	99.89	99.86
100	12	10	10	1	2	94.50	245.67	23.88	23.90	25.72	25.71	99.89	99.86
100	13	10	10	1	2	97.36	255.22	23.88	23.90	25.72	25.71	99.89	99.86
100	14	10	10	1	2	99.46	263.08	23.88	23.90	25.72	25.71	99.89	99.86
Number of domestic firms													
100	10	10	10	1	2	86.46	221.53	23.88	23.90	25.72	25.71	99.89	99.86
100	10	10	11	1	2	81.07	213.02	21.04	21.06	22.89	22.88	90.24	90.22
100	10	10	12	1	2	76.28	205.61	18.65	18.66	20.44	20.43	82.18	82.16
100	10	10	13	1	2	72.00	199.11	16.62	16.63	18.33	18.32	75.35	75.34
100	10	10	14	1	2	68.16	193.36	14.89	14.90	16.50	16.50	69.51	69.50
100	10	10	15	1	2	64.71	188.24	13.41	13.42	14.93	14.92	64.47	64.46
θ Parameter variation													
100	10	10	10	1	0	86.46	221.53	23.88	23.88	25.71	25.71	99.86	99.86
100	10	10	10	1	2	86.46	221.53	23.88	23.90	25.72	25.71	99.89	99.86
100	10	10	10	1	10	86.46	221.53	23.88	24.44	25.86	25.71	100.49	99.86
100	10	10	10	1	100	86.46	221.53	23.88	80.12	40.63	25.71	162.71	99.86

Table 18: Simulation Results for the Large Market

The above four tables display the threshold values for a number of variations in the parameters. These are used to derive the following rankings that will assist in the analysis in the main part of the chapter. The values for the parameters have been chosen so as to ensure that production is positive in all entry mode situations and that the levels of cost and tariff are not too high relative to the market parameter a . Note that these threshold values in some situations have a negative sign. This implies that since G is assumed to always be positive, when compared to these threshold values, the greenfield cost will always be greater than

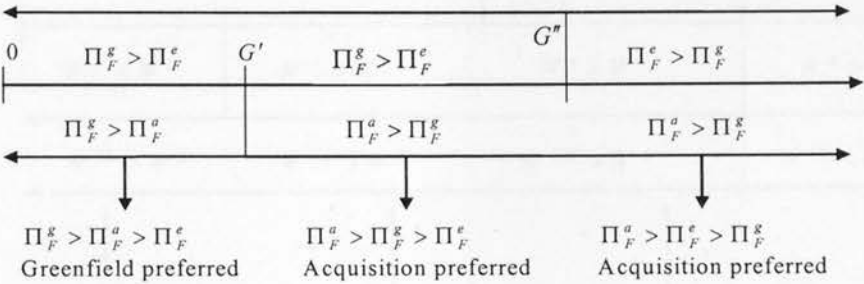
those and thus the preferred mode will be chose accordingly. For example, if $G^{***} < 0$, then G will always be greater, as it is positive, thus $G > G^{***}$, therefore greenfield will always be preferred to no entry.

C.8 Appendix 8

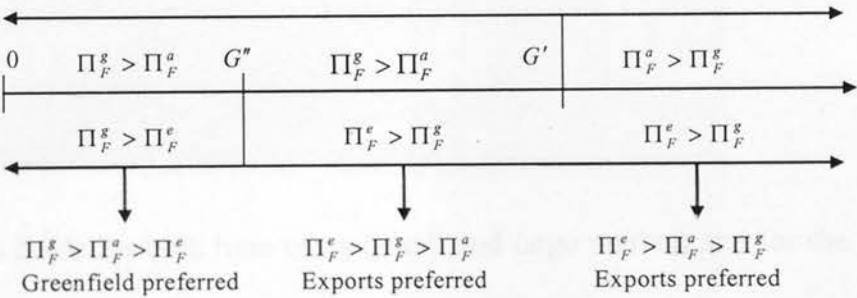
symmetry

The separate rankings for the government and firm in the symmetric case can take the following form:

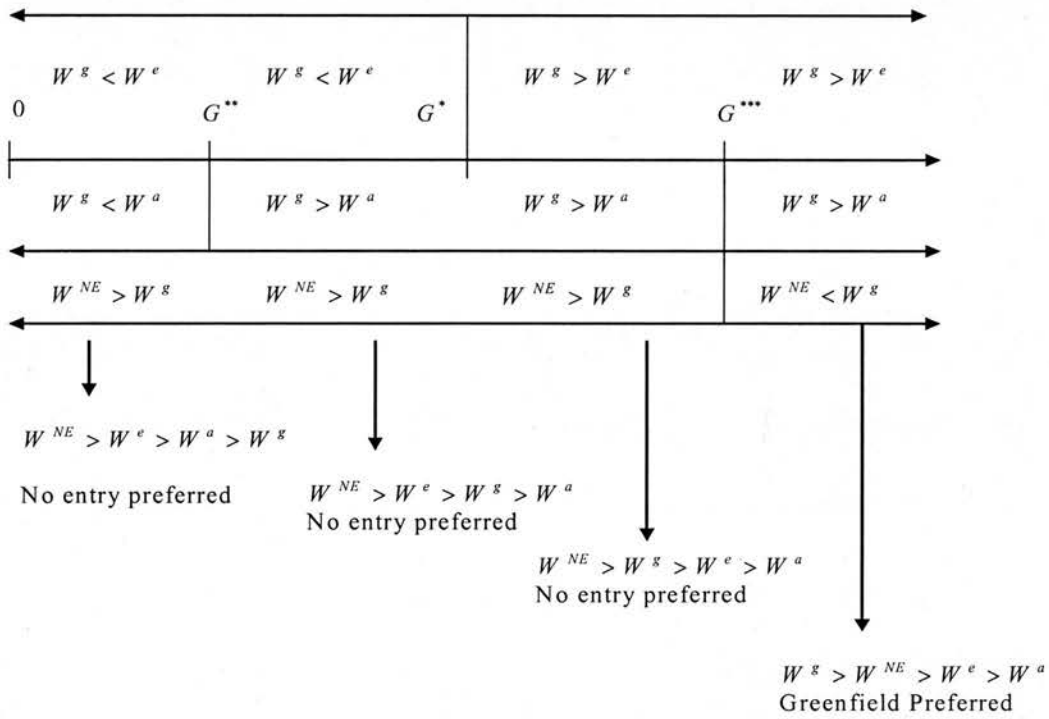
Firm



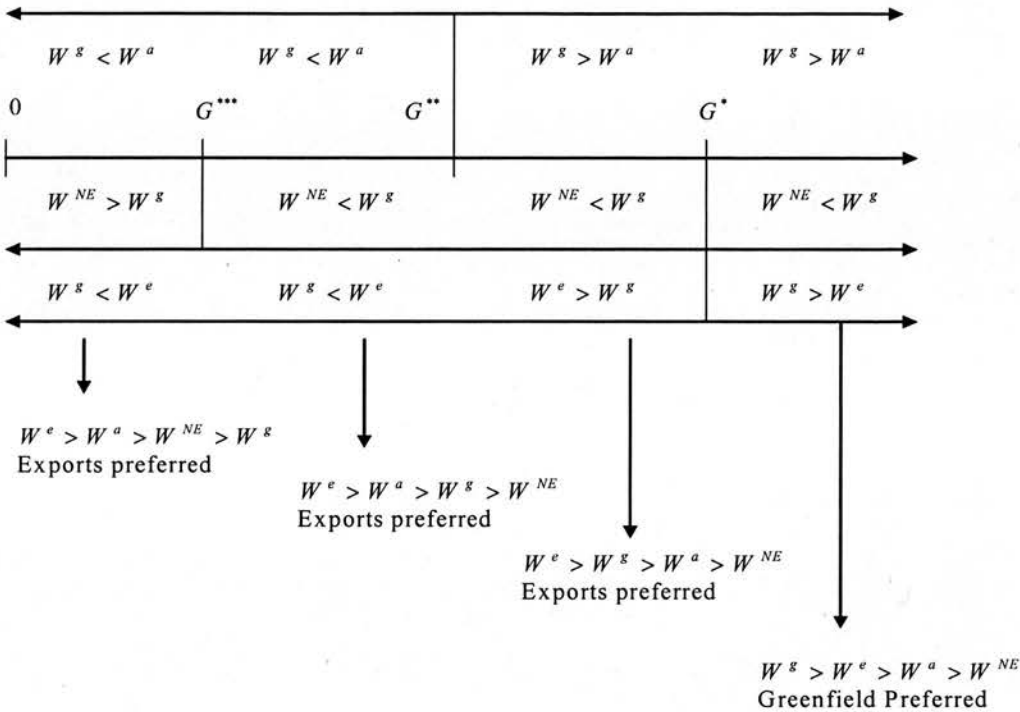
This ranking holds generally with the exception of the situation in the small market when the variation σ^2 is high (case 4), in which case, the following holds:



On the other hand, for the government:

Government

This holds for both base cases (small and large market) and for the small market case 2 (large tariff), case 3 (large number of firms), case 4 (high variation) and for the large market case 4. The following ranking prevails for the case of high cost in the market, keeping the remaining variable constant.

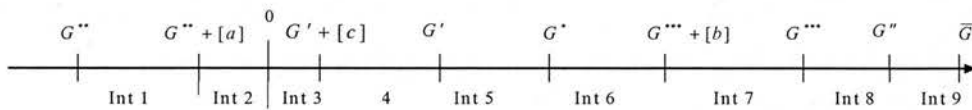


C.9 Appendix 9

Rankings

Small market

Base case -low cost, low tariff, low number of firms, low bargaining power, low variation.



For $\beta = 1$

If $G \in [0, G' + [c]]$ then for both the symmetric and asymmetric cases the government prefers no entry by the foreign firm, whereas the firm prefers to enter through greenfield investment.

If $G \in [G' + [c], G']$ then the policymaker prefers no entry in both the symmetric and asymmetric cases, whereas the firm prefers greenfield investment in the symmetric case and acquisition in the asymmetric one.

If $G \in [G', G^*] [G^*, G^{***} + [b]]$, the policymaker prefers no entry, whereas the foreign firm prefers to enter through acquisition in both the symmetric and asymmetric cases.

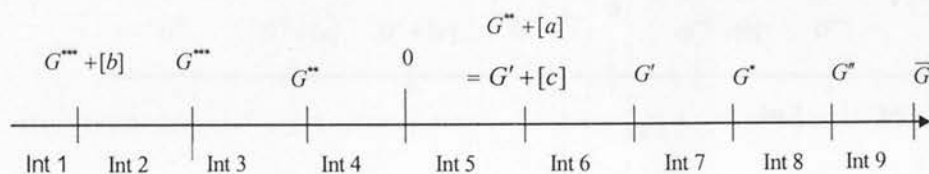
If $G \in [G^{***} + [b], G^{***}]$ then the policymaker prefers no entry in the symmetric case and greenfield investment in the asymmetric case, when the policymaker prefers acquiring a domestic firm as its strategy in both the symmetric and asymmetric cases.

If $G \in [G^{***}, G']$ then the policymaker prefers greenfield investment and the firm prefers acquisition in both the symmetric and asymmetric cases.

For $\beta = 0$

If $G \in [G', \bar{G}]$ then the policymaker prefers greenfield investment and the firm prefers acquisition in both the symmetric and asymmetric cases.

Case 1- High cost



For $\beta = 1$

If $G \in [0, G^{**} + [a] = G' + [c]]$ the government prefers importing from the foreign firm (thus would rather have the foreign firm exporting towards their domestic market) whereas the firm would prefer greenfield investment in both the symmetric and asymmetric cases.

If $G \in [G^{**} + [a] = G' + [c], G']$, the government prefers importing from the foreign firm in both the symmetric and asymmetric cases, whereas the firm prefers greenfield investment in the symmetric case and acquisition in the asymmetric case.

If $G \in [G', G^*]$ the government prefers importing and the firm prefers acquisition in both the symmetric and asymmetric cases.

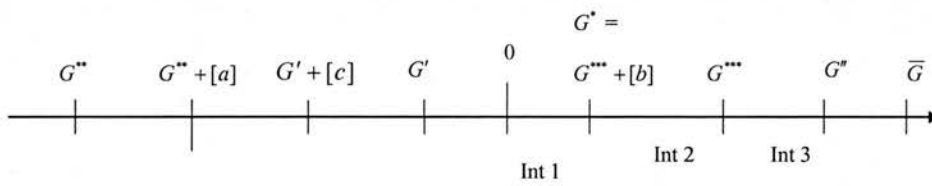
If $G \in [G^*, G'']$ the government prefers greenfield investment as the foreign entry mode, whereas the firm would prefer to enter through an acquisition.

For $\beta = 0$

If $G \in [G'', \bar{G}]$ the government prefers greenfield investment as the foreign entry mode, whereas the firm would prefer to enter through an acquisition.

Case 2-High Tariff

For $\beta = 1$

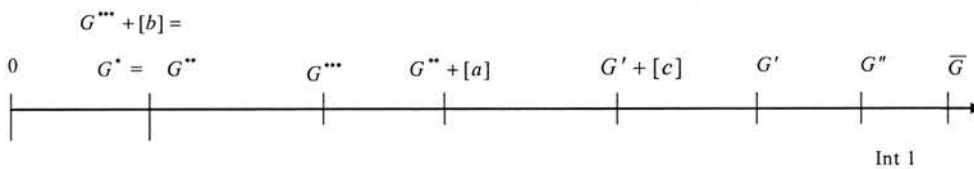


If $G \in [0, G^{***} + [b] = G^*]$ the government prefers no entry by the foreign firm, whereas the firm prefers to enter through an acquisition.

If $G \in [G^{***} + [b] = G^*, G^{***}]$ the government prefers no entry in the symmetric case and entry through greenfield investment in the asymmetric one, whereas the firm in both cases would prefer to enter through the acquisition of a domestic firm.

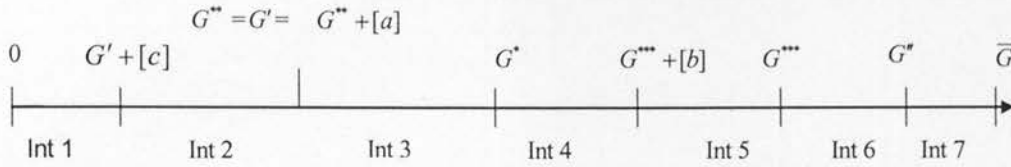
If $G \in [G^{***}, G'']$ the government prefers entry through greenfield investment, whereas the firm would prefer to enter through an acquisition.

For $\beta = 0$



If $G \in [G'', \bar{G}]$ the government prefers entry through greenfield investment, whereas the firm would prefer to enter through an acquisition.

Case 3-High number of firms



For $\beta = 1$

If $G \in [0, G' + [b]]$ the government prefers no entry by the foreign firm, whereas the firm prefers entry through greenfield investment in both symmetry and asymmetry.

If $G \in [G' + [b], G^{***} + [a] = G^{**} = G']$ the government prefers no entry by the foreign firm, whereas the firm would prefer greenfield investment as its entry mode in the case of symmetry and acquisition in the case of asymmetry.

If $G \in [G^{***} + [a] = G^{**} = G', G^*]$, $[G^*, G^{***} + [b]]$, the government prefers no entry by the foreign firm, whereas the firm chooses acquisition as its entry mode.

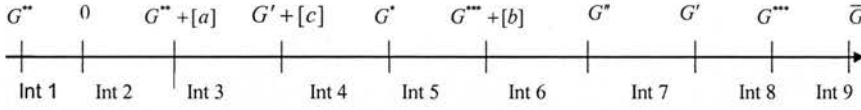
If $G \in [G^{***} + [b], G^{***}]$ the government prefers no entry in the symmetric case and greenfield investment in the asymmetric case, whereas the firm prefers acquisition.

If $G \in [G^{***}, G'']$ the government prefers greenfield investment as the foreign entry mode and the firm prefers acquisition.

For $\beta = 0$

If $G \in [G'', \bar{G}]$ the government prefers greenfield investment as the foreign entry mode and the firm prefers acquisition.

Case 4-High variation



For $\beta = 1$

If $G \in [0, G'' + [a]]$, $[G'' + [a], G' + [c]]$ then for both the symmetric and asymmetric cases the government prefers no entry by the foreign firm, whereas the firm prefers to enter through greenfield investment.

If $G \in [G' + [c], G^*]$, $[G^*, G^{***} + [b]]$ the government prefers no entry in both symmetry and asymmetry, whereas the firm chooses greenfield in symmetry and acquisition in asymmetry.

If $G \in [G^{***} + [b], G'']$ the government prefers no entry in the symmetric case and greenfield in the asymmetric whereas the firm prefers greenfield investment in the symmetric case and acquisition in the asymmetric case.

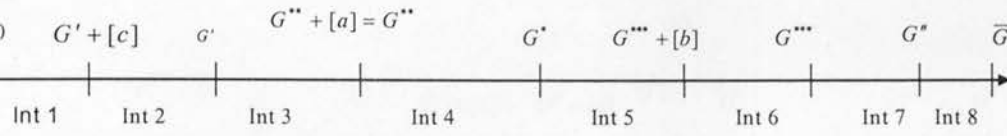
For $\beta = 0$

If $G \in [G'', G']$, $[G', G^{***}]$ the government prefers no entry in the symmetric case and greenfield investment in the asymmetric case, whereas the firm prefers exports in the symmetric case and acquisition in the asymmetric case.

If $G \in [G^{***}, \bar{G}]$ the government prefers greenfield investment in both the symmetric and asymmetric cases whereas the firm prefers exports in the symmetric case and acquisition in the asymmetric case.

Large Market

Base Case



For $\beta = 1$

If $G \in [0, G' + [c]]$ the government prefers no entry by the foreign firm whereas the firm prefers Greenfield investment.

If $G \in [G' + [c], G']$ the government prefers no entry by the foreign firm in both the symmetric and asymmetric cases, whereas the firm prefers Greenfield investment in the symmetric case and acquisition in the asymmetric case.

If $G \in [G', G^{**} + [a] = G^{**}], [G^{**} + [a] = G^{**}, G^*], [G^*, G^{***} + [b]]$ the government prefers no entry whereas the foreign firm chooses acquisition as its entry mode.

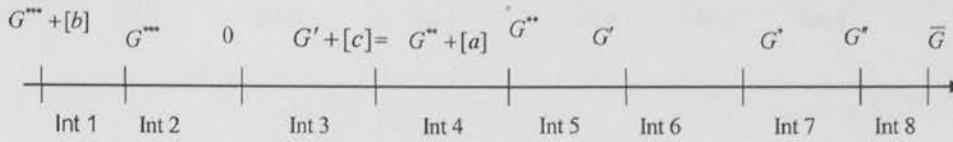
If $G \in [G^{***} + [b], G^{***}]$ the government prefers no entry in the symmetric case and Greenfield investment in the asymmetric case, whereas the firm prefers to enter through acquisition in both situations.

If $G \in [G^{***}, G'']$ the government prefers Greenfield investment as the foreign entry mode, whereas the firm chooses to enter through acquisition.

For $\beta = 0$

If $G \in [G'', \bar{G}]$ the government prefers Greenfield investment as the foreign entry mode, whereas the firm chooses to enter through acquisition.

Case 1-High Cost



For $\beta = 1$

If $G \in [0, G' + [c] = G'' + [a]]$ the government prefers exports as the entry mode of the foreign firm, whereas the firm prefers Greenfield investment.

If $G \in [G' + [c] = G'' + [a], G'']$, $[G'', G']$ the government prefers exports as the foreign entry mode, whereas the firm prefers Greenfield investment in the symmetric case and acquisition in the asymmetric case.

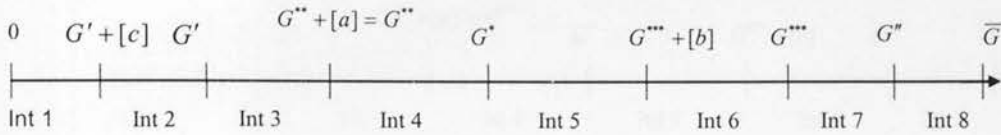
If $G \in [G', G^*]$ the government prefers exports as the foreign entry mode, whereas the firm prefers acquisition of a domestic firm.

If $G \in [G^*, G'']$ the government prefers greenfield investment as the foreign entry mode, in contrast to the acquisition option of the firm.

For $\beta = 0$

If $G \in [G'', \bar{G}]$ the government prefers greenfield investment as the foreign entry mode, in contrast to the acquisition option of the firm.

Case 2- High Tariff



For $\beta = 1$

If $G \in [0, G' + [c]]$ the government prefers no entry by the foreign firm, whereas the firm prefers to enter through Greenfield investment.

If $G \in [G' + [c], G']$, the government prefers no entry by the foreign firm in both the symmetric and asymmetric cases, whereas the firm prefers Greenfield investment in the symmetric case and acquisition in the asymmetric case.

If $G \in [G', G^{**} + [a] = G^{**}]$, $[G^{**} + [a] = G^{**}, G^*]$, $[G^*, G^{***} + [b]]$ the government prefers no entry whereas the foreign firm chooses acquisition as its entry mode.

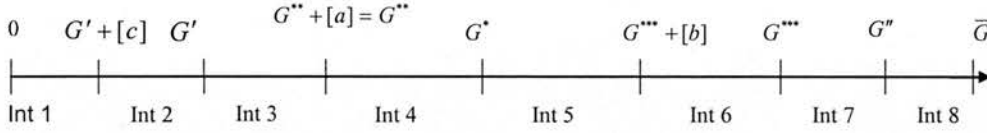
If $G \in [G^{***} + [b], G^{***}]$ the government prefers no entry in the symmetric case and Greenfield investment in the asymmetric case, whereas the firm prefers to enter through acquisition in both situations.

If $G \in [G^{***}, G'']$ the government prefers Greenfield investment as the foreign entry mode, whereas the firm chooses to enter through acquisition.

For $\beta = 0$

If $G \in [G'', \bar{G}]$ the government prefers Greenfield investment as the foreign entry mode, whereas the firm chooses to enter through acquisition.

Case 3 - High number of firms



For $\beta = 1$

If $G \in [0, G' + [c]]$ the government prefers no entry by the foreign firm, whereas the firm prefers to enter through Greenfield investment.

If $G \in [G' + [c], G']$, the government prefers no entry by the foreign firm in both the symmetric and asymmetric cases, whereas the firm prefers Greenfield investment in the symmetric case and acquisition in the asymmetric case.

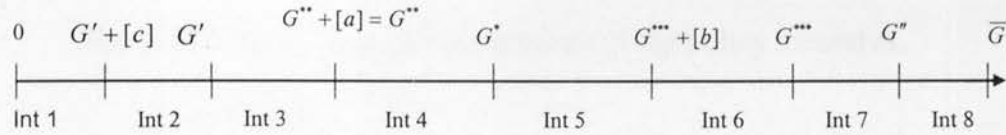
If $G \in [G', G^{**} + [a] = G^{**}], [G^{**} + [a] = G^{**}, G^*], [G^*, G^{***} + [b]]$ the government prefers no entry whereas the foreign firm chooses acquisition as its entry mode.

If $G \in [G^{***} + [b], G^{***}]$ the government prefers no entry in the symmetric case and Greenfield investment in the asymmetric case, whereas the firm prefers to enter through acquisition in both situations.

If $G \in [G^{***}, G'']$ the government prefers Greenfield investment as the foreign entry mode, whereas the firm chooses to enter through acquisition.

For $\beta = 0$

If $G \in [G'', \bar{G}]$ the government prefers Greenfield investment as the foreign entry mode, whereas the firm chooses to enter through acquisition.

Case 4 - High variation

For $\beta = 1$

If $G \in [0, G' + [c]]$ the government prefers no entry by the foreign firm, whereas the firm prefers to enter through Greenfield investment.

If $G \in [G' + [c], G']$, the government prefers no entry by the foreign firm in both the symmetric and asymmetric cases, whereas the firm prefers Greenfield investment in the symmetric case and acquisition in the asymmetric case.

If $G \in [G', G^{**} + [a] = G^{**}]$, $[G^{**} + [a] = G^{**}, G^*]$, $[G^*, G^{***} + [b]]$ the government prefers no entry whereas the foreign firm chooses acquisition as its entry mode.

If $G \in [G^{***} + [b], G^{***}]$ the government prefers no entry in the symmetric case and Greenfield investment in the asymmetric case, whereas the firm prefers to enter through acquisition in both situations.

If $G \in [G^{***}, G'']$ the government prefers Greenfield investment as the foreign entry mode, whereas the firm chooses to enter through acquisition.

For $\beta = 0$

If $G \in [G'', \bar{G}]$ the government prefers Greenfield investment as the foreign entry mode, whereas the firm chooses to enter through acquisition.

C.10Appendix 10

Simulation results from the comparison of the policy measures.

Small Market

For $\beta = 1$

							No entry vs Greenfield Symmetry	No entry vs Acquisition Symmetry +Asymmetry	Exports vs Acquisition Symmetry	Exports vs Acquisition Asymmetry	No entry vs Greenfield Asymmetry	No entry vs Exports Symmetry
Small Market												
Cost												
10	1	1	2	1	2		-5.60	-4.61	3.30	3.24	-5.19	-3.19
10	1	2	2	1	2		-9.53	-9.56	2.27	2.22	-9.13	-6.25
10	1	3	2	1	2		-14.32	-14.83	1.88	1.82	-13.92	-10.16
10	1	4	2	1	2		-19.97	-20.44	2.11	2.05	-19.57	-14.94
10	1	5	2	1	2		-26.49	-26.39	2.96	2.91	-26.08	-20.58
Tariff												
10	1	1	2	1	2		-5.60	-4.61	3.30	3.24	-5.19	-3.19
10	2	1	2	1	2		-5.60	-4.61	1.20	1.15	-5.19	-1.47
10	3	1	2	1	2		-5.60	-4.61	0.55	0.49	-5.19	-0.44
10	4	1	2	1	2		-5.60	-4.61	1.33	1.27	-5.19	-0.10
Number of domestic firms												
10	1	1	3	1	2		-3.90	-3.53	0.69	0.62	-3.62	-1.86
10	1	1	4	1	2		-3.09	-2.94	-0.32	-0.38	-2.89	-1.27
10	1	1	5	1	2		-2.63	-2.57	-0.77	-0.83	-2.48	-0.96
10	1	1	6	1	2		-2.34	-2.32	-1.00	-1.05	-2.22	-0.77
10	1	1	7	1	2		-2.13	-2.13	-1.12	-1.16	-2.04	-0.64
10	1	1	8	1	2		-1.98	-1.99	-1.19	-1.22	-1.91	-0.55
10	1	1	9	1	2		-1.87	-1.89	-1.23	-1.25	-1.81	-0.48
10	1	1	10	1	2		-1.78	-1.80	-1.25	-1.27	-1.73	-0.43
θ Parameter variation												
10	1	1	3	1	0		-3.85	-3.53	0.62	0.62	-3.85	-1.81
10	1	1	3	1	2		-3.90	-3.53	0.69	0.62	-3.62	-1.86
10	1	1	3	1	10		-4.98	-3.53	2.37	0.62	1.90	-2.94
10	1	1	3	1	100		-116.35	-3.53	175.62	0.62	571.15	-114.31

Table 19: Simulation Results for the Small Market

For $\beta = 0$

						No entry vs Greenfield Symmetry	No entry vs Acquisition Symmetry +Asymmetry	Exports vs Acquisition Symmetry	Exports vs Acquisition Asymmetry	No entry vs Greenfield Asymmetry	No entry vs Exports Symmetry
Small Market											
Cost											
10	1	1	2	0	2	-5.60	-4.61	3.30	3.24	-5.19	-3.19
10	1	2	2	0	2	-9.53	-9.56	2.27	2.22	-9.13	-6.25
10	1	3	2	0	2	-14.32	-14.83	1.88	1.82	-13.92	-10.16
10	1	4	2	0	2	-19.97	-20.44	2.11	2.05	-19.57	-14.94
10	1	5	2	0	2	-26.49	-26.39	2.96	2.91	-26.08	-20.58
Tariff											
10	1	1	2	0	2	-5.60	-4.61	3.30	3.24	-5.19	-3.19
10	2	1	2	0	2	-5.60	-4.61	1.20	1.15	-5.19	-1.47
10	3	1	2	0	2	-5.60	-4.61	0.55	0.49	-5.19	-0.44
10	4	1	2	0	2	-5.60	-4.61	1.33	1.27	-5.19	-0.10
Number of domestic firms											
10	1	1	3	0	2	-3.90	-3.53	0.69	0.62	-3.62	-1.86
10	1	1	4	0	2	-3.09	-2.94	-0.32	-0.38	-2.89	-1.27
10	1	1	5	0	2	-2.63	-2.57	-0.77	-0.83	-2.48	-0.96
10	1	1	6	0	2	-2.34	-2.32	-1.00	-1.05	-2.22	-0.77
10	1	1	7	0	2	-2.13	-2.13	-1.12	-1.16	-2.04	-0.64
10	1	1	8	0	2	-1.98	-1.99	-1.19	-1.22	-1.91	-0.55
10	1	1	9	0	2	-1.87	-1.89	-1.23	-1.25	-1.81	-0.48
10	1	1	10	0	2	-1.78	-1.80	-1.25	-1.27	-1.73	-0.43
θ Parameter variation											
10	1	1	3	0	0	-3.85	-3.53	0.62	0.62	-3.85	-1.81
10	1	1	3	0	2	-3.90	-3.53	0.69	0.62	-3.62	-1.86
10	1	1	3	0	10	-4.98	-3.53	2.37	0.62	1.90	-2.94
10	1	1	3	0	100	-116.35	-3.53	175.62	0.62	571.15	-114.31

Table 20: Simulation Results for the Small Market

*Large Market*For $\beta = 1$

						No entry vs Greenfield Symmetry	No entry vs Acquisition Symmetry +Asymmetry	Exports vs Acquisition Symmetry	Exports vs Acquisition Asymmetry	No entry vs Greenfield Asymmetry	No entry vs Exports Symmetry
Large Market											
<i>Cost</i>											
100	10	10	10	1	2	-177.92	-179.75	-126.73	-126.75	-177.87	-42.85
100	10	20	10	1	2	-513.95	-520.66	-249.38	-249.41	-513.90	-246.94
100	10	30	10	1	2	-1014.70	-1022.73	-347.09	-347.12	-1014.64	-615.74
100	10	40	10	1	2	-1680.16	-1685.95	-419.86	-419.88	-1680.10	-1149.25
100	10	50	10	1	2	-2510.33	-2510.33	-467.69	-467.71	-2510.28	-1847.49
<i>Tariff</i>											
100	10	10	10	1	2	-177.92	-179.75	-126.73	-126.75	-177.87	-42.85
100	11	10	10	1	2	-177.92	-179.75	-133.94	-133.97	-177.87	-34.35
100	12	10	10	1	2	-177.92	-179.75	-139.33	-139.35	-177.87	-26.75
100	13	10	10	1	2	-177.92	-179.75	-142.89	-142.91	-177.87	-20.07
100	14	10	10	1	2	-177.92	-179.75	-144.62	-144.64	-177.87	-14.29
100	15	10	10	1	2	-177.92	-179.75	-144.53	-144.55	-177.87	-9.43
100	16	10	10	1	2	-177.92	-179.75	-142.61	-142.63	-177.87	-5.47
<i>Number of domestic firms</i>											
100	10	10	10	1	2	-177.92	-179.75	-126.73	-126.75	-177.87	-42.85
100	10	10	11	1	2	-170.73	-172.57	-127.30	-127.32	-170.69	-38.78
100	10	10	12	1	2	-164.78	-166.57	-127.30	-127.32	-164.74	-35.45
100	10	10	13	1	2	-159.78	-161.48	-126.97	-126.99	-159.74	-32.66
100	10	10	14	1	2	-155.50	-157.11	-126.45	-126.46	-155.47	-30.31
100	10	10	15	1	2	-151.81	-153.32	-125.81	-125.82	-151.78	-28.28
<i>θ Parameter variation</i>											
100	10	10	10	1	0	-177.92	-179.75	-126.75	-126.75	-177.92	-42.85
100	10	10	10	1	2	-177.92	-179.75	-126.73	-126.75	-177.87	-42.85
100	10	10	10	1	10	-177.98	-179.75	-126.19	-126.75	-176.66	-42.91
100	10	10	10	1	100	-184.52	-179.75	-70.51	-126.75	-52.23	-49.45

Table 21: Simulation Results for the Large Market

For $\beta = 0$

						No entry vs Greenfield Symmetry	No entry vs Acquisition Symmetry +Asymmetry	Exports vs Acquisition Symmetry	Exports vs Acquisition Asymmetry	No entry vs Greenfield Asymmetry	No entry vs Exports Symmetry
Large Market											
Cost											
100	10	10	10	0	2	-177.92	-179.75	-126.73	-126.75	-177.87	-42.85
100	10	20	10	0	2	-513.95	-520.66	-249.38	-249.41	-513.90	-246.94
100	10	30	10	0	2	-1014.70	-1022.73	-347.09	-347.12	-1014.64	-615.74
100	10	40	10	0	2	-1680.16	-1685.95	-419.86	-419.88	-1680.10	-1149.25
100	10	50	10	0	2	-2510.33	-2510.33	-467.69	-467.71	-2510.28	-1847.49
Tariff											
100	10	10	10	0	2	-177.92	-179.75	-126.73	-126.75	-177.87	-42.85
100	11	10	10	0	2	-177.92	-179.75	-133.94	-133.97	-177.87	-34.35
100	12	10	10	0	2	-177.92	-179.75	-139.33	-139.35	-177.87	-26.75
100	13	10	10	0	2	-177.92	-179.75	-142.89	-142.91	-177.87	-20.07
100	14	10	10	0	2	-177.92	-179.75	-144.62	-144.64	-177.87	-14.29
100	15	10	10	0	2	-177.92	-179.75	-144.53	-144.55	-177.87	-9.43
100	16	10	10	0	2	-177.92	-179.75	-142.61	-142.63	-177.87	-5.47
Number of domestic firms											
100	10	10	10	0	2	-177.92	-179.75	-126.73	-126.75	-177.87	-42.85
100	10	10	11	0	2	-170.73	-172.57	-127.30	-127.32	-170.69	-38.78
100	10	10	12	0	2	-164.78	-166.57	-127.30	-127.32	-164.74	-35.45
100	10	10	13	0	2	-159.78	-161.48	-126.97	-126.99	-159.74	-32.66
100	10	10	14	0	2	-155.50	-157.11	-126.45	-126.46	-155.47	-30.31
100	10	10	15	0	2	-151.81	-153.32	-125.81	-125.82	-151.78	-28.28
θ Parameter variation											
100	10	10	10	0	0	-177.92	-179.75	-126.75	-126.75	-177.92	-42.85
100	10	10	10	0	2	-177.92	-179.75	-126.73	-126.75	-177.87	-42.85
100	10	10	10	0	10	-177.98	-179.75	-126.19	-126.75	-176.66	-42.91
100	10	10	10	0	100	-184.52	-179.75	-70.51	-126.75	-52.23	-49.45

Table 22: Simulation Results for the Large Market

C.11Appendix 11

Proof of equivalence between subsidy and tax.

The government has two policy options in its disposal: one would be to provide positive incentives that would make its own preferred option more attractive by increasing profits for the firm or to provide negative incentives (a tax) that would make the firm's preferred option less attractive by reducing its profits.

Subsidy in favour of the government's preferred option k (versus the firm's preferred option l)

Firm's incentives:

$$E(\Pi_F^{mk}) + S_F^{mk(l)} \succeq E(\Pi_F^{ml}) \Leftrightarrow S_F^{mk(l)} \succeq E(\Pi_F^{ml}) - E(\Pi_F^{mk})$$

Therefore the minimum subsidy the firm is willing to accept in order to switch its mode is equal to: $S_F^{mk(l)} = E(\Pi_F^{ml}) - E(\Pi_F^{mk})$.

Government's incentives:

$$E(W_p^{mk}) - S_p^{mk(l)} \succeq E(W_p^{ml}) \Leftrightarrow S_p^{mk(l)} \leq E(W_p^{mk}) - E(W_p^{ml})$$

Therefore $S_p^{mk(l)} = E(W_p^{mk}) - E(W_p^{ml})$ is the maximum level of subsidy the policy maker would be willing to provide, where $m \in [A, S]$ denotes asymmetry and symmetry, $k \in [e, g, acq, ne]$ denotes the government's optimal choice and $l \in [e, g, acq, ne]$ the foreign firm's choice.

For a mode switch the condition is:

$$S_p^{mk(l)} > S_F^{mk(l)} \Rightarrow S_p^{mk(l)} - S_F^{mk(l)} > 0$$

In terms of expected profits and welfare the condition becomes:

$$E(W_p^{mk}) - E(W_p^{ml}) - E(\Pi_F^{ml}) + E(\Pi_F^{mk}) > 0$$

Tax against the firm's preferred option l :

Firm's incentives:

$$E(\Pi_F^{mk}) \succeq E(\Pi_F^{ml}) + (-T_F^{mk(l)}) \Leftrightarrow -T_F^{mk(l)} \preceq E(\Pi_F^{mk}) - E(\Pi_F^{ml})$$

Therefore the maximum tax accepted by the firm in order not to switch its mode is equal to: $-T_F^{mk(l)} = E(\Pi_F^{mk}) - E(\Pi_F^{ml})$.

Government's incentives:

$$E(W_p^{mk}) \succeq E(W_p^{ml}) - (-T_p^{mk(l)}) \Leftrightarrow -T_p^{mk(l)} > E(W_p^{ml}) - E(W_p^{mk})$$

Therefore $-T_p^{mk(l)} = E(W_p^{ml}) - E(W_p^{mk})$ is the minimum tax level the policy maker would be willing to accept as payment for the firm not to switch its mode. Note that $-T^{mk(l)} < 0$.

a. No mode switch

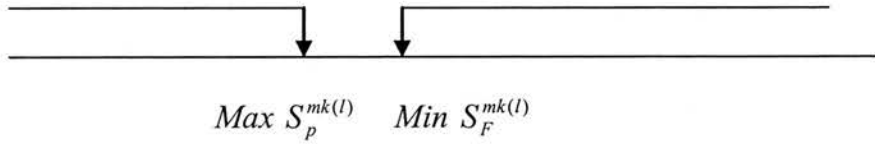


Figure 1: No Mode Switch

b. Mode switch

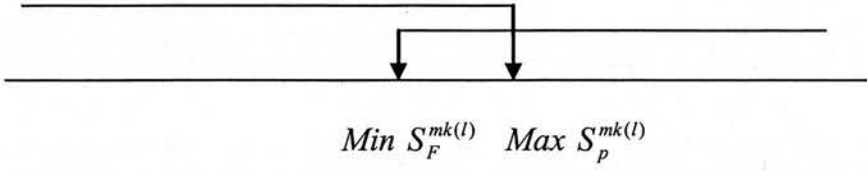


Figure 2: Mode Switch

Thus for a mode switch we must have:

$$-T_F^{mk(l)} > -T_p^{mk(l)} \Rightarrow -T_F^{mk(l)} + T_p^{mk(l)} > 0$$

\Rightarrow

$$E(\Pi_F^{mk}) - E(\Pi_F^{ml}) - E(W_p^{ml}) + E(W_p^{mk}) > 0$$

\Rightarrow

$$E(W_p^{mk}) - E(W_p^{ml}) + E(\Pi_F^{mk}) - E(\Pi_F^{ml}) > 0$$

Thus the condition that must be satisfied for mode switch to occur is the same whether a tax or a subsidy is used as a policy measure and thus the two are equivalent in terms of a mode switch framework.